CONSIDERING CHILDHOOD OBESITY THROUGH AN INVESTIGATION OF MATERNAL/INFANT FACTORS AND THE ACCEPTABILITY OF A TEXT MESSAGE-BASED INTERVENTION

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAIʻI AT MĀNOA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

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ABSTRACT

Addressing childhood obesity in low-income groups in Hawai‘i and Puerto Rico requires examination of maternal and infant risk factors and evaluation of related interventions to advance preventive measures. This dissertation, entitled “Considering childhood obesity: an investigation of maternal/infant factors and the acceptability of a text message-based intervention,” includes a general overview of the dissertation, a literature review describing previous studies on factors contributing to childhood obesity and text message-based interventions, three stand-alone manuscripts, a concluding chapter that includes additional comments and future considerations, and appendices containing documents pertinent to the intervention and other information. The three stand-alone manuscripts present studies on a text message-based intervention aimed at promoting breastfeeding and preventing excessive weight gain in infants enrolled in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) in Hawai‘i and Puerto Rico. The studies 1) assess the acceptability of the intervention; 2) examine the association between maternal pregravid body mass index (BMI) and breastfeeding discontinuation; and 3) examine the association between gestational weight gain and rate of infancy weight gain. Main findings include the following: 1) the text message-based intervention was acceptable to participants based upon qualitative and quantitative measures; 2) breastfeeding discontinuation was not associated with pregravid BMI, but Native Hawaiian or Other Pacific Islanders (adjusted odds ratio [AOR]=7.12; 95% confidence interval [CI]=1.34, 37.97; p=0.02) and older women (AOR=4.21; 95% CI=1.13, 15.72; p=0.03) showed significantly higher odds of discontinuing breastfeeding before four to six months postpartum; and 3) excessive and inadequate gestational weight gain was associated with decreased proportional odds of rapid infancy weight gain versus on-track (AOR=0.23; 95% CI=0.08, 0.70; p=0.01) or slow (AOR=0.29; 95% CI=0.09, 0.94;

p=0.04) infant weight gain. These findings may inform childhood obesity prevention strategies and programs.

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LIST OF ABBREVIATIONS

25-OH-D	25-hydroxyvitamin D
AAP	American Academy of Pediatrics
ANOVA	analysis of variance
AOR	adjusted odds ratio
BF	breastfeeding
BMI	body mass index
CDC	Centers for Disease Control and Prevention
CI	confidence interval
COR	crude odds ratio
FFQ	food frequency questionnaire
FTT	failure to thrive
GWG	gestational weight gain
HI	Hawai‘i
IOM	Institute of Medicine
mHealth	mobile health
NHANES	National Health and Nutrition Examination Survey
NHOPI	Native Hawaiian or Other Pacific Islander
OMB	US Office of Management and Budget
OR	odds ratio
OWOB	overweight or obese
p	p-value
PRAMS	Pregnancy Risk Assessment Monitoring System
PR	Puerto Rico
RCT	randomized controlled trial
RIWG	rapid infancy weight gain
SD	standard deviation
TFA	theoretical framework of acceptability
UN	underweight or normal weight

US	United States
WHO	World Health Organization
WIC	Special Supplemental Nutrition Program for Women, Infants, and Children

CHAPTER 1. OVERVIEW OF DISSERTATION

Introduction

Childhood obesity is a global public health concern that is associated with problems later in life such as overweight, obesity, high blood pressure, and diabetes.[1–4] Low-income[5] and minority groups, such as Native Hawaiian or Other Pacific Islander (NHOPI),[6,7] have high rates of overweight and obesity. Figure 1.1 illustrates the prevalence of overweight and obesity in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) in Hawai‘i and Puerto Rico for participants aged two to four years.[8–11] In comparison, the 2011-2014 National Health and Nutrition Examination Survey (NHANES) reported that 8.9% of United States (US) children aged two to five years were obese,[12] indicating a higher prevalence of obesity in these WIC populations. Such disparities warrant further investigation of the maternal and infant factors involved in childhood obesity in these groups. Hawai‘i and Puerto Rico WIC clinics provided a suitable study population for this dissertation. The Hawai‘i WIC clinics used in these studies were operated by the State of Hawai‘i and located on the island of Oahu in Wahiawa, Pearl City, Honolulu (Nimitz), and Waipahu (Leeward). The Puerto Rico WIC clinics were located in San Juan (Hato Rey) and Trujillo Alto.

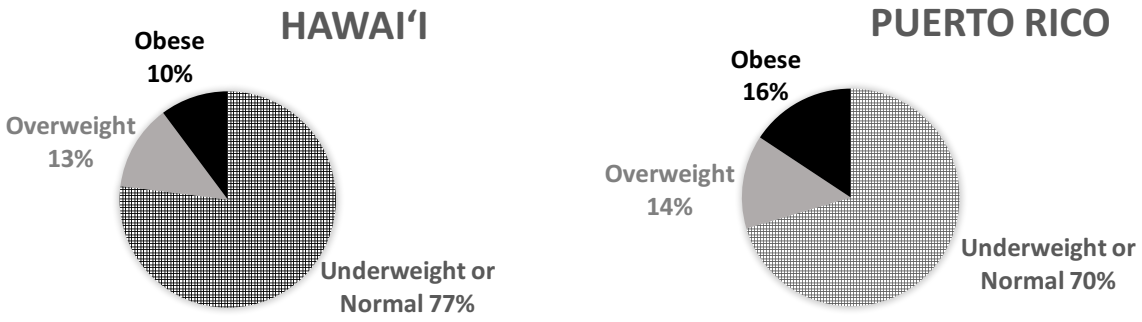

Figure 1.1. Childhood overweight and obesity in Hawai‘i and Puerto Rico WIC participants 2-4 years old in 2012[8–11]

This dissertation explores childhood obesity: 1) by determining the acceptability of a text-message based intervention aimed at preventing excessive weight gain in at-risk infants; 2) by examining the association between maternal pregravid body mass index (BMI) and breastfeeding discontinuation at four to six months postpartum; and 3) by investigating the association between gestational weight gain and rate of infancy weight gain at four to six months postpartum.

Statement of the Problem and Rationale for the Studies

To prevent childhood obesity, it is important to promote appropriate breastfeeding practices. Although the breastfeeding rate at six months increased from 51.8% of infants in 2013 to 55.3% in 2014,[13] the US has not yet met the Office of Disease Prevention and Health Promotion's Healthy People 2020 goal of 60.6% for infant breastfeeding at six months.[14] Figure 1.2 presents the 2014 breastfeeding rates in the US, Hawai'i, and Puerto Rico in comparison to the Healthy People 2020 Goals. Work is still needed to increase breastfeeding rates in certain racial groups[15] and in areas of the US such as Puerto Rico. Moreover, additional disparities exist regarding cessation of breastfeeding prior to six months that deserve further investigation.

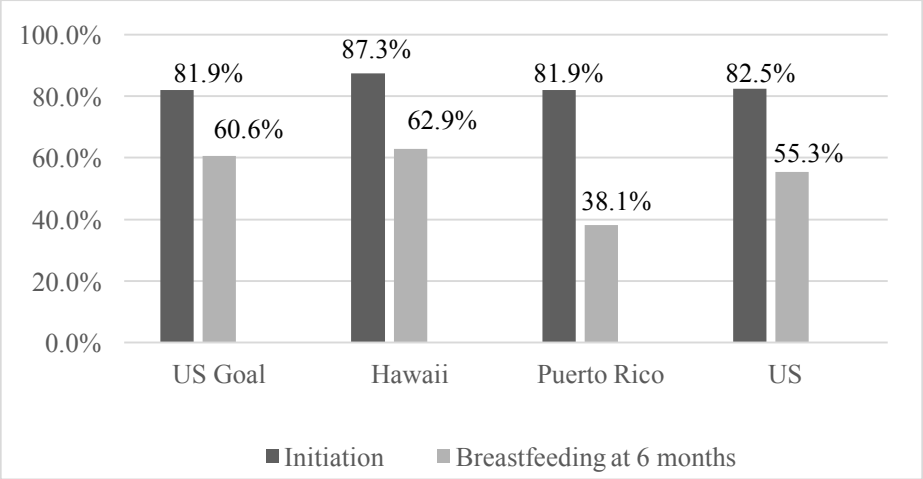

Figure 1.2. Healthy People 2020 goals and breastfeeding rates for children born in 2014 in Hawai'i, Puerto Rico, and the US[13]

Since traditional face-to-face interventions aiming to improve breastfeeding and infant feeding practices have yielded mixed results,[16] novel approaches using technology such as text messaging to deliver education may be more effective with at-risk mothers who may be difficult to reach. Text message-based interventions have been shown to be effective in promoting behavioral change, an important aspect of obesity prevention, and provide a low-cost and convenient way of delivering education.[17–20]

The first study in this dissertation assessed the acceptability of a text message-based intervention designed to promote breastfeeding and to reduce excessive infant weight gain. Feasibility and acceptability assessments can contribute to the improvement of mobile health (mHealth) interventions and to increased participant retention,[21,22] thereby improving the effectiveness of intervention strategies. However, only a few studies using text messaging to promote healthy infant growth also assessed acceptability of the interventions (Table 1.1) and there is a need to understand the acceptability of text message-based interventions specifically focused on infant outcomes related to childhood obesity prevention. This study assessed the acceptability of text messaging as an intervention strategy for obesity prevention in infants from lower socioeconomic backgrounds in Hawai‘i and Puerto Rico.

Table 1.1. Examples of studies using text messaging to promote healthy infant growth

Study	Population	Objectives	Assessed acceptability
Duan[23] (2016)	Mother-infant pairs (n=192) in Mongolia	To investigate the effects of delivering infant feeding knowledge using mobile phone text messages on improving infant growth and anemia at 6 months	No
Horodynski[24] (2015)	Low-income adolescent mothers in Michigan (n=100)	To improve infant weight at 3-6 months using text messaging and social media to deliver infant feeding information for 6 weeks	No
Gallegos[25] (2014)	Breastfeeding adult Australian women (n=114)	To assess a weekly mobile phone text messaging intervention to increase breastfeeding rates and improve breastfeeding self-efficacy and coping	Yes

For the second and third studies in this dissertation, the relationships between maternal or infant risk factors for obesity were investigated. These factors were maternal pregravid BMI, breastfeeding discontinuation, gestational weight gain, and rate of infancy weight gain.

Table 1.2 describes previous studies that have identified maternal pregravid BMI as a predictor of childhood overweight/obesity. Some studies (Table 1.3) have reported associations between maternal pregravid BMI and breastfeeding duration at six months in minority populations in the US;[26,27] however, none have investigated this association in low-income groups in Hawai‘i or Puerto Rico. Hipanic[28] and NHOPI groups have high rates of overweight and obesity,[6,7] so there is a need for additional research in these at-risk populations. This study contributes new knowledge about the association between pregravid BMI and breastfeeding discontinuation at four to six months postpartum in Hawai‘i and Puerto Rico WIC participants.

Table 1.2. Examples of studies on maternal pregravid body mass index (BMI) as a predictor of childhood overweight/obesity

Study	Population	Outcomes
Li[29] (2005)	Children 2-14 years (n=2636) from 1996 US National Longitudinal Survey of Youth	Overweight BMI resulted in 2.4 times the risk of overweight, obese BMI resulted in 3.6 times the risk of overweight in offspring at 2-14 years
Sewell[30] (2006)	Normal glucose tolerant women (n=220) and their offspring in Ohio	Pregravid obesity was associated with increased fat mass in newborn offspring but not in lean body mass
Catalano[31] (2009)	Children (n=89) and their mothers at Case Western Reserve University in Ohio	High pregravid BMI was a significant risk factor for childhood obesity in children at 8-11 years

Table 1.3. Examples of studies reporting associations between pregravid body mass index and breastfeeding duration

Study	Population	Outcomes
Kugyelka[26] (2004)	Hispanic and Black healthy mothers in New York (n=2527)	Pregravid obesity was negatively associated with initiation and duration of breastfeeding in Hispanic but not in Black women
Liu[27] (2010)	South Carolina PRAMS[a] data (n=6363)	Pregravid obesity was negatively associated with initiation and duration of breastfeeding in White but not in Black women
Oddy[32] (2006)	Mothers from the Western Australian Pregnancy Cohort Study, which included Asian and Aboriginal women (n=1803)	Pregravid overweight or obesity was associated with reduced duration of breastfeeding at 2, 4, and 6 months postpartum
Li[33] (2003)	US mother-child pairs (n=51329), including 14.5% Black and 14% Hispanic	Women with pregravid obesity breastfed for 2 weeks less than normal weight women

[a]PRAMS: Pregnancy Risk Assessment Monitoring System

As shown in Table 1.4, studies have indicated that excessive gestational weight gain is associated with increased adiposity[34] and increased risk of greater BMI[35] and obesity[36,37] in offspring. Similarly, studies have reported that rapid infancy weight gain is associated with obesity later in life (Table 1.5).[38–42] In a systematic review conducted in 2006, the authors identified 21 published articles in which all studies reported statistically significant positive associations between weight gain in the first two years and subsequent obesity.[42] In Hawai‘i, rapid growth from 12 to 23 months has been associated with obesity at four to five years in low-income Filipino and NHOPI children.[43] However, this study was the first to assess the association between gestational weight gain and rate of infancy weight gain in low-income groups at high risk of overweight/obesity in Hawai‘i and Puerto Rico.

Table 1.4. Examples of studies reporting excessive gestational weight gain (GWG) that impacted offspring weight

Study	Population	Outcomes
Oken[34] (2007)	Mother-child pairs (n=1044) in Project Viva in Massachusetts	Mothers with greater GWG had children with greater adiposity at 3 years as measured by BMI[a] and skinfold thickness
Mourtakos[35] (2016)	Children (n=5125) in Greece	Excessive GWG associated with higher risk of high BMI at 2 and 8 years
Mourtakos[36] (2015)	Children (n=5125) in Greece	Excessive GWG associated with obesity at 8 years
Hillier[44] (2016)	Mother-child pairs (n=24,141) in Northwest and Hawai‘i	Excessive GWG associated with increased risk of obesity in adolescence and early adulthood
Chihara[45] (2014)	Hawai‘i WIC[b] participants	Excessive GWG associated with high birth weight

[a]BMI: body mass index; [b]WIC: Special Supplemental Nutrition Program for Women, Infants, and Children

Table 1.5. Examples of studies reporting the association between rapid infancy weight gain (RIWG, change in weight-for-age z-score >+0.67) up to age two years and later obesity

Study	Population	Outcomes
Ong[42] (2006)	Systematic review of 21 studies: US, Seychelles, Holland, Sweden, UK, Brazil, Iceland, South Africa, Germany, Switzerland, Japan, France (n=37,522 combined)	1. For all 21 studies, statistically significant association between RIWG in first 2 years and later obesity 2. Increased risk for obesity per 0.67 z-score weight gain (OR[a] 1.26 – 4.55)
Ong[40] (2000)	Random selection of infants (n=848) from Avon Longitudinal Study of Pregnancy and Childhood in United Kingdom	Children displaying catch up growth (RIWG) before 2 years were heavier, taller, and had more central fat at 5 years
Demerath[41] (2009)	White children (n=233) in Fels Longitudinal Study (Ohio)	1. RIWG in first 2 years associated with +7 kg body fat and +3 kg abdominal adipose tissue later in life (mean age 46.5 years) 2. Infants with RIWG had significantly increased risk overweight (OR 5.54) and obesity (OR 4.08) in adulthood

[a]OR: odds ratio

Research Objectives and Hypotheses

Organized by manuscript (chapter), Table 1.6 presents the research questions, study objectives, and hypotheses for this dissertation. Figure 1.3 illustrates how the studies in this dissertation (indicated by *) are connected to the larger intervention study and other reports.

Table 1.6. Dissertation research questions, objectives, and hypotheses, organized by manuscript (chapter)

	Research question	Study objective	Hypothesis
Manuscript 1 (Chapter 3)	What were the major themes regarding the usefulness of the messages and how participants were influenced to change behaviors? Which messages were liked the most/least?	To determine the acceptability of a text message-based intervention for obesity prevention in infants.	N/A
Manuscript 2 (Chapter 4)	How was maternal pregravid BMI[a] associated with breastfeeding discontinuation in Hawai‘i and Puerto Rico WIC participants?	To examine the association between maternal pregravid BMI and breastfeeding discontinuation at 4-6 months postpartum.	Low-income women in Hawai‘i and Puerto Rico with pregravid BMI≥25 had greater odds of discontinuing breastfeeding at 4-6 months postpartum than women with pregravid BMI<25.
Manuscript 3 (Chapter 5)	How was gestational weight gain associated with rate of infancy weight gain in Hawai‘i and Puerto Rico WIC participants?	To examine the association between excessive gestational weight gain and rate of infancy weight gain in the first 4-6 months.	Excessive gestational weight gain in low-income women in Hawai‘i and Puerto Rico was positively associated with rapid infancy weight gain in the first 4-6 months.

[a]BMI: body mass index

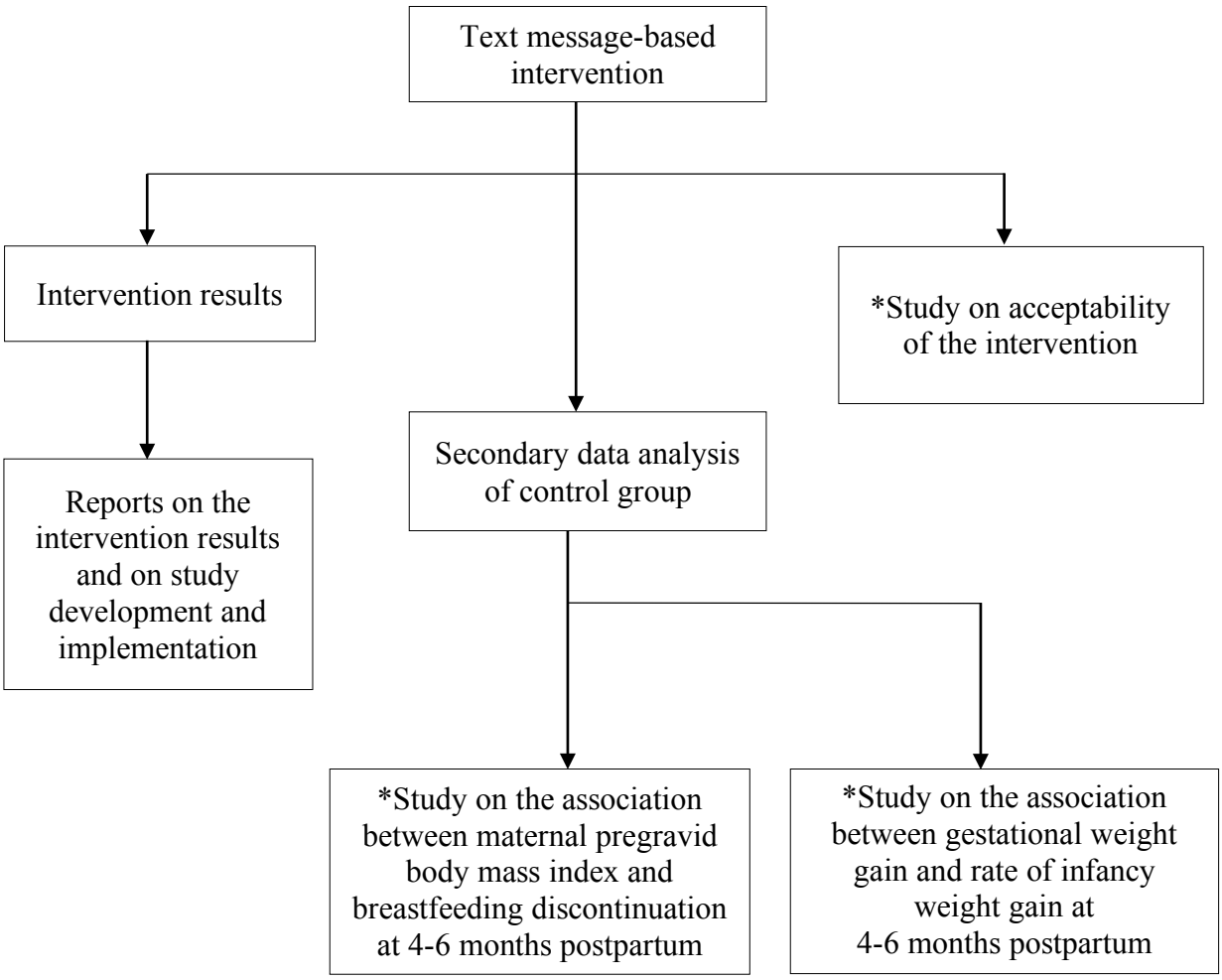

Figure 1.3. Layout of studies and reports conducted from the text message-based intervention, with dissertation studies marked with *

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CHAPTER 2. LITERATURE REVIEW

This literature review 1) explores childhood overweight and obesity by discussing current recommendations, mechanisms, problems, and disparities and by describing previous studies on associated factors; and 2) describes previous studies using text messaging and discusses text message-based interventions, including their advantages and significance. The main objective of this review is to establish the need for further research 1) in populations at risk for childhood obesity, particularly low-income infants in Hawai‘i and Puerto Rico; and 2) in mobile health (mHealth) intervention strategies, such as text messaging. Findings will be used to determine associations between obesity-related factors of interest and to determine the need for acceptability studies in text message-based interventions for childhood obesity prevention.

Overweight and Obesity in Children

Growth measurements

For children under the age of two years, the 2006 World Health Organization (WHO) growth charts for children from birth to 60 months old are the international standard for monitoring growth.[1] These standards, which represent optimal growth, were established using data from children of six countries who had non-smoker mothers, were breastfed for at least 12 months, and were predominately breastfed for the first four months.[1,2] For children under the age of two years, two standard deviations (SDs) away from the median, which corresponds to the 2.3rd and 97.7th percentiles, on the WHO growth charts are recommended for identifying those whose growth may indicate adverse health.[3] For children and adolescents ages five to 19 years, overweight is defined as one SD above the median (84th percentile) and obesity occurs at two SDs above the median (97.7th percentile, labeled as the 98th percentile) on the 2007 WHO Reference growth charts.[2–4]

Although the WHO provides standard growth charts for children up until the age of five years and reference charts for ages five through 19 years, the Centers for Disease Control and Prevention (CDC) recommends using the CDC growth charts to monitor growth of US children from two to 19 years[1] for the following reasons: 1) after age two years, the methods used to construct the CDC and WHO charts are similar; 2) the CDC charts continue through age 19

years; and 3) since length measurement changes from recumbent length to standing height at age two years, this is a feasible age to transition to the CDC charts.[3]

According to the CDC, childhood obesity and overweight are defined as having a body mass index (BMI), a measure of body weight in kilograms divided by height in squared meters,[5] at or above the 95th percentile and the 85th percentile, respectively, on the CDC growth charts for children and adolescents of the same sex and age.[6] The CDC growth charts are considered references rather than standards because they are not based upon optimal growth in children but rather upon data representing typical growth in United States (US) children during a specific time period.[1] The 2000 CDC growth charts were created from the revised 1977 National Center for Health Statistics growth charts, which based most of its data on work from the National Health and Nutrition Examination Survey (NHANES) primarily from the early 1960's through the 1990's.[7] Due to the mathematical nature of the percentile system, it has been stated that z-scores, which represent the number of SDs from the mean, are better measures than percentiles for assessing change in weight status over time.[2] However, percentiles are often used more in clinical settings due to their simplicity.[2]

Childhood obesity

Childhood obesity is associated with many adverse health conditions: cardiovascular risk factors such as high blood pressure, dyslipidemia, endothelial function abnormalities, and insulin resistance; systemic chronic inflammation; asthma; obesity later in life;[8] reduced quality of life;[9] type 1[10] and type 2[11] diabetes; and possibly reduced life expectancy.[12] Childhood obesity is a major public health concern and, since reversing overweight and obesity is extremely difficult, there has been an increased focus on preventive strategies aimed at younger age groups. According to the 2011-2012 NHANES, 7.1% of US infants and toddlers under the age of two years were at or above the 97.7th percentile, signifying high weight for length.[13] Globally, overweight and obesity in children from birth to five years old has increased from 32 million children in 1990 to 41 million in 2016.[14] The United Nations Population Division and Our World in Data estimate that the worldwide population of infants and children younger than five years old increased from 644 million in 1990 to 676 million in 2016, indicating that the percentage of

overweight and obese children in this age group increased from 5.0% in 1990 to 6.1% in 2016.[15,16]

The first six months after birth are a critical time of rapid growth during which, as the "growth acceleration hypothesis" suggests, metabolic programming can occur, leading to increased susceptibility to obesity later in life.[17–19] This hypothesis proposes that rapid infancy weight gain (RIWG), often represented by the upward crossing of percentile lines on growth charts, influences components of metabolic syndrome such as insulin resistance, higher low-density lipoprotein cholesterol concentration, obesity, and higher blood pressure.[19] Infants are especially vulnerable to nutritional and environmental exposures during the first six months for many reasons: 1) their organ systems maintain considerable adaptability during this time; 2) the gastrointestinal tract is more permeable; and 3) the metabolic environment is more easily influenced.[17]

For both breastfed and formula-fed infants, rapid weight gain during the first two months of life has been shown to be positively associated with overweight during later childhood.[18,20] Some of the reported biological mechanisms of metabolic programming that affect infant adiposity and weight gain are influenced by components in formula or human milk: 1) formula-feeding results in greater intake of calories and certain micronutrients and macronutrients, like protein;[18] 2) high ratios of linoleic acid to alpha-linolenic acid in either human milk or formula may favor excessive adipose deposition;[21,22] and 3) endocrine responses to bioactive substances, such as leptin and insulin, in breast milk may influence infant metabolism, appetite, and energy intake.[17,23,24] However, the mechanisms driving the associations between RIWG and childhood/adult obesity are not fully understood.[17]

Disparities

Previous studies have shown that disparities exist with regards to childhood obesity rates, with certain groups particularly at risk, such as low-income and minority children.[25,26] Native Hawaiian or Other Pacific Islander (NHOPI) groups have high rates of overweight and obesity,[27,28] as do Hispanic youth in Puerto Rico.[29] Taveras et al reported that Hispanic and Black children had increased odds of RIWG compared with White infants.[30] Another study by Oshiro et al reported that some minority groups in Hawai‘i, such as NHOPI, had higher BMI

between two and four months of age compared to other races.[31] Likewise, Okihiro et al reported that low-income NHOPI and Filipino pre-kindergarten children from the largest community health center in Hawai‘i had a high prevalence of obesity, with more than 42% being overweight or obese.[32] Nationally, in 2014, overweight or obesity occurred in 40% of one-year-olds and 30% of two to five-year-olds participating in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC),[33,34] a federally funded program for low-income women and children with gross household income at or below 185% of the US Poverty Income Guidelines.[35] In Hawai‘i, 12.8% of WIC participants ages two to four years were overweight and 10.2% were obese in 2012.[33,36,37] In Puerto Rico, 13.9% of WIC participants ages two to four years were overweight and 15.7% were obese in 2012.[33,38]

Disparities in body composition exist among several racial and ethnic groups, suggesting that the current BMI weight cut-off points may not be sufficiently representative of disease risk and body fatness in some populations. For example, Asian adults have been found to have a higher percentage of body fat than Whites of the same BMI, age, and sex.[39] Another study reported that a smaller waist circumference and lower BMI in Chinese adults more appropriately identified those at high risk of cardiovascular disease in comparison to the current standards.[40] A longitudinal study of Pacific Island children provided evidence of larger body size and suggested that the current BMI standards misrepresented the health risks in this population by overestimating overweight and obesity.[41] Similarly, Duncan et al reported that more than half of the Pacific Island girls in the study who were categorized by BMI as overweight actually had normal levels of body fat and that more than one-third of East Asian girls with excess body fat had BMI values below the overweight cut-off.[42] These findings supported other studies that showed Pacific Islanders had more muscle mass and lower body fat than other ethnicities at the same BMI, indicating that the current standard weight cut-off ranges may not be appropriate for all populations.[42–44] However, the WHO expert consultation has recommended that the current WHO BMI cut-off points be retained as the international standard but also has identified additional potential BMI action points and additional measurements that could help to tailor risk assessment in distinct populations.[39] Until more research has been completed to construct well-accepted ethnic-specific BMI reference standards, the CDC and WHO classifications for childhood overweight and obesity should probably be retained as well.

Rapid infancy weight gain

Studies have reported that rapid weight gain during early infancy is associated with problems later in life such as overweight, obesity, and comorbidities such as high blood pressure and diabetes.[45–51] Although weight gain rates vary during the first few years, rapid weight gain in the first two years has been associated with higher BMI, greater percentage of body fat, and more total fat mass.[52] In a systematic review conducted in 2006, the authors identified 21 published articles in which all studies reported statistically significant positive associations between weight gain in the first two years and subsequent obesity.[53] In another study, the same authors investigated the association of catch-up growth, a compensatory mechanism for intrauterine growth restraint[52,54] or low birth weight,[55] during the first two years and obesity at five years and found that children who displayed catch up growth, defined as a change in weight z-score >+0.67, were heavier, taller, and had more central fat than other children.[52] The association between RIWG (change in weight z-score >+0.67) in the first two years and central fat later in life was also demonstrated by Demerath et al; infants with rapid weight gain had about 7 kg more total body fat and 3 kg greater abdominal adipose tissue at age 30-61 years (mean age 46.5 years).[56] In comparison to infants with slower growth, infants with rapid weight gain had an increased risk for adult overweight and obesity of 5.54 and 4.08, respectively.[56] Similarly, during the first six months of life, Ekelund et al demonstrated that upward weight percentile crossing predicted larger BMI, greater waist circumference, and taller height in young adulthood.[54] Rapid weight gain of one z-score during the first six months was associated with 1.8 kg increase in fat mass during early childhood and 1.0 kg increase in fat free mass at age 17 years.[54]

The degree of RIWG may influence the severity of obesity risk. Wang et al conducted a prospective study in a large predominately minority cohort in Boston and studied the association of weight gain during the first two years and overweight/obesity at age two to seven years. Weight gain z-scores were categorized into four groups: slow (<−0.67), on track (−0.67 to 0.67), rapid (>0.67 to 1.28), and extremely rapid (>1.28). Overall, rates of weight gain determined at four months persisted significantly through age two years. Extremely rapid weight gain during the first two years was associated with 2.3 times greater risk of overweight/obesity, and rapid weight gain was associated with 1.6 times greater risk of later overweight/obesity in comparison

to the on-track group at age two to seven years. Interestingly, adjusting the data for breastfeeding (BF) duration and timing of solid food introduction did not change the results substantially.[57]

The association between RIWG and later obesity has been observed across various populations. A study conducted in Rural Western China concluded that RIWG, defined as a change in weight z-score >+0.67 between birth and 1.5 years, was a risk factor for obesity in early school-age children in this population.[25] And, a longitudinal study in Massachusetts by Taveras et al reported that upwards crossing of at least two weight-for-length percentile lines during the first two years was associated with later obesity in life.[58] In Hawai‘i, it was shown that a greater change in weight between two and 24 months was associated with higher BMI at age five[31] and that rapid growth from 12 to 23 months was associated with obesity at 4-5 years in low-income Filipino and NHOPI children.[32] Finally, a meta-analysis of 10 cohort studies in the United Kingdom, France, Sweden, the US, Finland, and Seychelles reported that each unit increase in weight-for-age z-score increased risk twofold for childhood obesity and by 23% for adult obesity.[59] Although these studies were conducted among a wide range of populations, all reported a positive association between infancy weight gain and obesity risk later in life.[59] Therefore, metabolic programming as a result of RIWG may be a significant factor in the development of obesity across diverse populations.[18]

Maternal gestational weight gain

Gestational weight gain (GWG) refers to the amount of weight that a woman gains during pregnancy from the time of conception until the onset of labor. Gestational weight gain supports the growth and development of the fetus and is influenced by several factors including maternal metabolism and physiology and placental metabolism.[60] There is a considerable amount of variation in GWG among women, with differences in fat mass accretion accounting for most of the variation.[60] However, the placenta, fetus, and amniotic fluid make up about 35% of total GWG in all women.[61] Other components that contribute to GWG include membranes, uterine and breast tissue, and fluid retention.[62]

Gestational weight gain monitoring is most often guided by the 2009 Institute of Medicine GWG guidelines which are based on pre-pregnancy BMI ranges, and these recommendations are aimed at optimizing outcomes for the woman and infant.[60] According to

these recommendations, underweight (BMI <18.5) women should gain 28-40 lb, normal-weight (18.5≤ BMI ≤24.9) women should gain 25-35 lb, overweight (25≤ BMI ≤29.9) women should gain 15-25 lb, and obese (BMI >30)[63] women should gain 11-20 lb during uniparous pregnancies.[60,64] Weight gain above these recommendations is considered excessive. In 2015, 32% of uniparous women who gave birth to a full-term infant in the US achieved GWG within the recommended ranges; but, 48% gained more weight and 21% gained less weight than recommended.[65,66]

Maternal weight gain during pregnancy may have significant effects on weight of offspring.[67] Genetic, dietary, physiological, or behavioral factors that increase GWG may also program offspring weight gain by altering the fetal intrauterine environment.[67,68] A large ethnically-diverse cohort study in Colorado reported positive associations between GWG and increased neonatal fat mass and body fat percentage, indicating that neonatal adiposity was influenced by maternal fat accumulation and the intrauterine environment during early and mid-pregnancy.[68] Another study in Mexico reported that, compared to women with recommended or insufficient GWG, women with excessive GWG in the third trimester had significantly higher levels of circulating insulin,[69] which may indicate increased levels of adipocyte development and fat storage[70] in the fetus. Excessive adipose tissue accumulation increases low-grade chronic inflammation and circulating adipokines, possibly creating an inflammatory environment for the fetus and promoting excess body fat accumulation in offspring.[71]

Other studies also have indicated that excessive GWG is associated with increased adiposity,[67,72] increased risk of greater BMI,[73] and obesity[74,75] in offspring. In a large prospective study, Oken et al reported that mothers with greater weight gain during pregnancy had children with greater adiposity at age three as measured by BMI and skinfold thickness.[67] Other studies have concluded that excessive GWG is associated with abnormal weight in offspring, with higher risk of high BMI at ages two and eight,[73] obesity at age eight,[74] and increased risk of obesity in adolescence and early adulthood.[75] In a large study conducted in the Northwest and Hawai‘i, excessive GWG was shown to increase childhood obesity risk independently from maternal hyperglycemia.[76] Excessive GWG in Hawai‘i WIC participants[77] and in non-Hispanic White and non-Hispanic Black South Carolina mothers[78] was associated with high birth weight. Gestational weight gain has been shown to be positively correlated (linear) with birth weight of

infants in Nepal.[79] The combined effect of pregravid obesity and excessive GWG in women in Tennessee has been shown to be associated with higher birth weight and increased weight-for-length percentile that was sustained throughout the first year of life.[80]

Birth weight

Although a large number of studies have reported that birth weight is positively associated with increased odds of childhood obesity,[81] this association has not been universally reported. For example, Lagstrom et al did not find a positive association between birth weight and overweight in adolescents.[82] And, both high and low birth weight, in comparison to normal birth weight, has been associated with obesity markers.[83]

There have been many reports on racial disparities in birth weight, such as one that showed birthweight was lower in Japanese infants and higher in Samoan infants, in comparison to non-Hispanic White infants.[84] Racial differences in maternal size and anthropometrics, such as GWG and gestational length, has been shown to greatly impact variability in fetal growth and birth weight.[84] Therefore, the association between birth weight and later obesity appears to be complicated by other factors.[85]

More than birth weight, catch-up growth during the first years of life is more closely linked to adiposity in adulthood.[56,83] The association between low birth weight and higher prevalence of diabetes and obesity in adults may be due to higher leptin levels and leptin-to-fat mass ratio during catch-up growth.[83] Moreover, it has been suggested that when using the WHO growth charts to assess later obesity, rapid growth patterns should be considered after the first month of birth when infants seemingly have settled in to growth trajectories.[86]

Maternal pregravid BMI

In comparison to underweight and normal-weight women, women who are overweight or obese prior to pregnancy are at increased risk of pregnancy complications, such as gestational diabetes, preeclampsia, and eclampsia, as well as adverse infant outcomes, such as fetal macrosomia and mortality.[87] Unfortunately, more than half of women in the US are overweight or obese at the time of conception.[88]

Pregravid overweight and obesity can have short- and long-term effects on offspring.[87,89] Maternal pregravid BMI has been shown to be a strong predictor of childhood overweight.[90] Compared to children whose mothers had normal pregravid BMI, Li et al found that children whose mothers were overweight or obese before pregnancy had an increased rate of being overweight at ages two to 14 years; overweight maternal pregravid BMI resulted in 2.4 times the risk of offspring overweight, and obese maternal pregravid BMI resulted in 3.6 times the risk of offspring overweight.[90] A Danish study reported that pregravid BMI was positively associated with infant weight gain at one year, although BF duration also contributed in the same direction to the observed variance.[91] Another study found that pregravid obesity was associated with increased fat mass in newborn offspring but not in lean body mass,[92] indicating an increased propensity for developing obesity.[93] A related study found that high maternal pregravid BMI was a significant risk factor for childhood obesity in children ages eight to 11 years.[94] In Hawai‘i, higher pregravid weight was associated with higher BMI in offspring at age five.[31]

Pregravid BMI may also influence other factors that are associated with offspring obesity. Several studies have reported negative associations between maternal pregravid BMI and BF duration at six months in minority populations in the US.[95–97] Additionally, an additive effect of pregravid BMI and lack of BF was reported in one US study in which maternal pregravid obesity and non-initiation of BF led to a six-fold increased risk of offspring overweight during childhood in comparison to normal maternal pregravid BMI and BF for at least four months.[90]

Gestational diabetes may be one factor possibly influencing the association between maternal pregravid obesity and offspring overweight.[90] In gestational diabetes, fetal programming and fetal insulin production may be key influencing factors leading to obesity later in life.[98] Postnatal environmental factors that may influence the development of obesity in children include parental obesity, especially for those under 10 years old,[99] and components affecting energy expenditure.[100] For example, a study in California found that overweight newborns with overweight mothers or fathers were 5.7 times more likely to become overweight in adolescence compared to overweight newborns with normal-weight parents.[100] Therefore, it is important to control for variables such as these when considering the true association between pregravid BMI and childhood obesity.

Breastfeeding

In working to prevent excessive weight gain in infants, it is important to promote appropriate BF and complementary feeding practices. The current recommendation from the American Academy of Pediatrics (AAP) is for babies to be exclusively breastfed for the first six months and then at least partially breastfed up until one year of life or beyond as mutually desired by baby and mother.[101,102]

Breastfeeding has been shown to be moderately yet consistently protective against obesity later in life.[17,90] According to the CDC, nine months of BF reduces an infant's risk of becoming overweight by more than 30%.[103] Moreover, research has shown that more protection from overweight and obesity is conferred by increasing the exclusivity and duration of BF.[104] A meta-analysis of 17 studies from several countries indicated a dose-dependent association between longer duration of BF and decreased later risk of overweight in comparison to exclusively formula-fed infants; for each month up until nine months, exclusive or partial BF reduced the later risk of overweight by 4%.[105] On the other hand, other infant feeding practices such as early introduction of solid foods has been shown to be associated with excessive weight gain.[30,106]

As demonstrated on the infant-age WHO growth charts, which are based upon breastfed infant growth only, in comparison to the CDC growth charts, breastfed infants generally display a faster rate of weight gain in the first three months.[107,108] After the first three months, formula-fed infants have shown increased rate of weight gain[23] but similar gain in length in comparison to breastfed infants who, subsequently, were leaner.[107] These differences in growth patterns between breastfed and formula-fed infants should be considered when assessing infant growth.[3]

The Office of Disease Prevention and Health Promotion's Healthy People 2020 goals include increasing the proportion of US infants who are breastfed at six months to 60.6%.[109] Studies in Hawai‘i have reported high breastfeeding initiation[110–113] and high prevalence of breastfeeding at six[111–113] months in comparison to the continental US. In 2016, the CDC reported data from the US National Immunization Surveys for infants born in 2013 which indicated that the rate of breastfeeding initiation in Hawai‘i was 90.6% and the rate of breastfeeding at six months was 65.3%, making Hawai‘i one of only 12 states that year which met the Healthy People 2020 goal for breastfeeding at six months.[112] However, the breastfeeding

initiation rate for children born in Hawai‘i in 2014 dropped slightly to 87.3% and the six month breastfeeding rate dropped to 62.9%.[113] For Puerto Rico, the rate of BF initiation was also high at 82.7% in 2013 and dropped slightly to 81.9% in 2014.[113] However, the rate of BF at six months was much lower than the Healthy People 2020 goal at only 37.1% in 2013 and 38.1% in 2014.[112,113] Nationally, rates at six months postpartum are also below the Healthy People 2020 goal, with only 55.3% of infants being breastfed at six months.[113] Persistent effort is needed to increase BF rates in certain racial groups, such as Black mothers,[114] and in areas of the US showing low BF rates, such as Puerto Rico. Moreover, there are additional disparities associated with cessation of BF prior to six months that warrant further investigation.

An understanding of the factors influencing early BF cessation is important for the development of prevention and educational strategies. In Hawai‘i, Novotny et al cited risk factors of early weaning as things like problems starting BF, problems with breasts, full-time employment outside of the home, Japanese ethnicity, and insufficient milk.[111] A study in Maryland, Washington DC, and Illinois indicated that variables involved in shorter duration of BF in English-speaking Hispanic women compared to White or Black women included married status, history of BF, younger age, and lack of a college degree.[115] In WIC infants in Puerto Rico, BF duration was associated with age of introduction of drinks other than breastmilk and caregiver’s educational level.[116]

Overweight and obese maternal pregravid BMI may be an important indicator of risk for early cessation of BF.[117] One biological factor that likely causes overweight and obese women to stop BF is a lower prolactin response to suckling.[117] This diminished response may lead to compromised milk production and, subsequently, to premature cessation of BF.[117] Delayed lactogenesis II, or a delay in the onset of copious milk production after birth, is associated with overweight or obese BMI[118] and exhibited a significant effect on cessation of BF at four weeks postpartum in a study with almost 2,500 US women.[119]

There may be racial differences involved in the association between pregravid BMI and BF duration. In a review of the literature in October 2010, it was reported that most studies reviewed found that overweight and obese women had an increased risk for failure to initiate BF and decreased duration of BF.[95] Two studies reported that the negative association between pregravid overweight/obesity BMI and BF duration during the first six months was significant in

Hispanic[96] and White[97] women in comparison to their normal-weight counterparts; but, this association was not found in Blacks.[96,97] Instead, these studies found that overall, regardless of BMI, Blacks were found to breastfeed for shorter duration than Whites[97] but for longer duration than Hispanics.[96]

Hawai‘i has a racially diverse and high minority population with at least 50% of the population being Black, Asian, NHOPI, or Hispanic, according to the 2016 United States Census.[120] And, according to the 2010 Hawai‘i Pregnancy Risk Assessment Monitoring System (PRAMS) Breastfeeding Fact Sheet, obese maternal pregravid BMI was associated with less BF initiation and BF for less than eight weeks in Hawai‘i mothers.[121] Therefore, it appears that race may play a role in the degree of influence that pregravid BMI has on BF duration.

Composition of human breast milk and formula

Human breast milk contains protein, fat, carbohydrates, vitamins, minerals, hormones, enzymes, immune cells, and water.[122] Although the composition of breast milk changes and adapts to the needs of the growing child, mature milk is generally composed of 87% water, 6.9-7.2% lactose, 3-5% fat, 0.8-0.9% protein, and 0.2% mineral ash, with fat and lactose providing most of the calories.[122,123]

Human breast milk contains protective bioactive components not found in formula such as leptin, adiponectin, ghrelin, and insulin-like growth factor-I which may be beneficial in mediating biological processes involved in the development of obesity.[23,24] These hormones may help regulate growth and may influence metabolic programming in ways that lower risk of childhood obesity in breastfed individuals.[124] For example, higher levels of adiponectin in breast milk are associated with lower weight and leaner body composition during the first six months in the breastfed infant and in older children, and circulating adiponectin levels are inversely associated with inflammation and adiposity.[125] Leptin, another adipokine found in breast milk, helps to regulate satiety and may be important in metabolic programming and food intake responses.[23] Human milk may also confer other physiological benefits such as stronger gastrointestinal[126] and respiratory health,[127] stronger immune system defenses,[23,128] improved neural development,[129] and reduced infant mortality.[130,131]

On the other hand, components in formula may increase weight gain in infants. Formula with greater protein concentration than what is found in breast milk has been shown to increase weight gain in low birth weight infants[132] and in small for gestational age infants, possibly contributing to increased fat mass at age six to eight years.[133] Similarly, in healthy full-term infants, those who received formula with higher protein concentration versus formula with lower levels of protein had an increased rate of weight gain but no difference in length growth, an indicator of lean body mass, indicating greater adiposity.[134] Additionally, different types of protein in formula may affect weight gain[135] and satiety.[136]

The composition of human milk can vary among women; maternal obesity alters the nutritional profile of breast milk and may increase infant growth, adiposity,[17] risk of developing diabetes, and may lead to impaired glucose tolerance later in life.[137] In comparison to lean women, obese and overweight mothers were shown to produce breast milk that is higher in fat,[138] glucose, and insulin.[139] Maternal BMI has been shown in many studies to be positively associated with breast milk concentration of leptin,[124,140] which reduces appetite and increases energy expenditure,[141] and a study by Miralles et al showed that milk leptin concentration in non-obese mothers at one month postpartum was negatively correlated with infant body weight and with infant weight gain throughout the first two years of age.[124] Therefore, leptin may be an important component of breast milk during the first months of life that contributes to lowering the risk of excessive weight gain in breastfed infants, especially in those with obese mothers.[124]

Maternal diets may also alter breast milk composition and contribute to increased infant weight. One study showed that, in comparison to a reduced-calorie high carbohydrate maternal diet (25% fat, 60% carbohydrate), an isocaloric high fat diet (55% fat, 30% carbohydrate) resulted in a higher percentage of fat in breast milk and increased fat and total energy intake in the breastfed infant.[142] In another study, the fatty acid profile in breast milk was altered between a low fat diet (18% fat, 68% carbohydrate) and an isocaloric high fat diet (40% fat, 45% carbohydrate); the concentration of medium chain fatty acids were significantly higher when consuming a low fat diet and certain long chain fatty acids (steric and alpha-linolenic acids) were significantly higher when consuming the high fat diet, which contained twice as much alpha-linolenic acids.[143] Medium chain fatty acids are absorbed more efficiently than long chain fatty acids and may increase postprandial energy expenditure[144] and, therefore, may confer helpful

effects on weight in breastfed infants. Obesity is associated with high levels of inflammation, and alpha-linolenic acids are known to reduce inflammation.[145–148] Therefore, the total amount and composition of fat in the maternal diet likely influences breastfed infant weight and health.

Vitamin and mineral supplements

Breast milk is considered the best source of nutrition for most infants and is adequate in most vitamins and minerals, with the exception of vitamin D and K.[122] However, a vitamin K shot (1 mg) is routinely administered at birth.[149] The AAP recommendation for daily intake of vitamin D is 400 IU/day for all infants, children, and adolescents, beginning in the first few days of life.[150] This recommendation is based upon evidence that 1) particularly during winter, breastfeeding infants have very low concentrations of 25-hydroxyvitamin D (25-OH-D), the nutritional indicator of vitamin D status; 2) vitamin deficiency can occur early in life, especially when women are deficient during pregnancy; 3) it is difficult to determine the amount of sun exposure needed to maintain adequate 25-OH-D serum levels; and 4) 400 IU of vitamin D is sufficient to maintain >50 nmol/L of serum 25-OH-D in breastfed infants.[150] The AAP also recommends that 1) term healthy infants who are breastfed take 1 mg/kg/day of liquid iron supplements starting at four months until iron-containing foods are introduced into the diet; 2) formula-fed infants should be fed formula that is iron-fortified; and 3) premature infants may need additional iron (2-4 mg/kg/day).[151] Low birth weight infants or infants fed unfortified formulas may have suboptimal intake of folate, but currently there is no formal recommendation for folic acid supplementation in infants.[152]

According to the WHO recommendations, all postnatal women should receive iron and folic acid supplementation for at least three months after giving birth.[153] Routine vitamin A supplementation is not recommended for public health purposes, but instead, women should consume balanced healthy diets.[154] Women who are not consuming enough nutrients are recommended to receive individualized diet counseling or nutrient supplementation, such as with multivitamins, vitamin B_{12}, calcium, and vitamin D.[155]

Text Message-Based Interventions

Text message-based interventions definition and features

Text message-based interventions are a type of mHealth technology that use text messages, or Short Message Service, for health promotion and disease prevention. Educational information, reminders, questions, tips, and other correspondence are delivered and received via text messages through an online platform. Using text messaging allows researchers to easily and quickly communicate with participants to offer advice or to resolve problems. This method also makes it possible to quickly identify non-responders in order to improve compliance.[156] Importantly, text message-based interventions have been shown to be well accepted in many nutrition studies.[157–160]

Advantages and significance in research

Text messaging is a commonly-used technology. In 2011, the Pew Research Center reported that about 83% of American adults own a mobile phone and that 73% of them use text messaging.[161] American adults who use text messages were reported to send or receive an average of 41.5 text messages daily.[161] Young adults are the greatest users of text messaging, with 95% of 18-24 year olds owning a mobile phone and 97% of them using text messaging.[161] The average number of text messages sent or received daily in this group is 109.5.[161] Moreover, the number of mobile phone users who use text messaging is increasing worldwide[159,162] and at least 95% of countries in the world have mobile phone networks.[163]

Mobile phones are good tools to use in health interventions because of their increasing popularity, their ease of usability, and people's tendency to always carry them.[164] Mobile phone technologies that support mHealth programs are evolving rapidly[159] and are potentially more effective than traditional face-to-face interventions which are more labor intensive, time consuming, and expensive.[156] In addition to being the most widely used technology in mHealth, text messaging is also the least expensive.[165] Instant yet asynchronous communication capabilities make text message-based interventions convenient for participants.[166] Moreover, studies have reported that they are non-invasive and not annoying.[157,159,167]

There are several reasons why text messaging can be a valuable tool in interventions. Text messaging offers flexible and diverse opportunities for participant and researcher

interaction and has been broadly adopted into different areas of health care for the following reasons: 1) convenience and accessibility; 2) "push" technology that allows text messages to be delivered without any effort from the recipient; 3) the ability for complete information exchange via mobile phones or computers; 4) the ability to log all correspondence; and 5) the ability to respond to users with automated customized feedback.[164] Text message-based interventions may be especially effective in certain groups, such as minorities, low-income, and those with lower levels of completed education because these groups were reported to text more than other groups.[161] Similarly, a study using a text message-based intervention in psychiatric care found that texting may be an effective way to reach groups that are difficult to access.[168] Text message-based interventions have been shown to be effective in behavioral change,[157,165–167] an important aspect of nutrition and obesity prevention strategies. And, text messaging can be an effective strategy for children because they have been shown to adhere well to and prefer using technology in interventions.[158,160] Moreover, since many traditional interventions aiming to improve feeding practices in infants have reported mixed results,[25] other methods using technology like text messaging may be more effective with at-risk mothers who may be difficult to reach.

Participant retention rates

In intervention studies, participant loss usually increases with time, and attrition can affect the power of a study to detect hypothesized differences, it can introduce selection bias, and it can affect generalizability.[169] In randomized controlled trials (RCTs) and cohort studies in nutrition, acceptable rates of attrition are not universally agreed upon.[169] Retention rates of 60-80% have been suggested as acceptable in epidemiological cohorts[170] and it has been indicated that retention rates ≤80% in RCTs may greatly affect validity.[169] Some infant nutrition RCTs have reported high retention rates of 80-90%,[171–174] but other nutrition studies have reported lower rates, such as a dietary behavioral weight loss study in obese adults that retained only 43-79% of participants.[175] However, it is possible that technology may help to increase participant retention. For example, a dietary behavioral weight loss study in overweight and obese adults that used text messaging retained 80% of participants.[176] An RCT using text messaging for adult adherence to a vitamin C regimen retained 97% of participants[177] and an RCT using text

messaging along with a mobile food record to improve nutrition behaviors reported a 89% retention rate.[178] Additionally, an RCT for monitoring health behaviors in children showed that children in the text message group had better participant retention (72%) in comparison to the non-technology (39%) and control (50%) and significantly greater adherence (43%) to self-monitoring in comparison to the non-technology (19%) groups.[160] Other nutrition studies utilizing text messaging have reported participant retention rates ranging from 66-77%,[157,179,180] but it is still likely that text messaging may be a more effective intervention tool than traditional strategies in some studies.

Table 2.1 presents the participant retention rate in other text message-based interventions. These mHealth studies used text messaging as the main method of intervention delivery. Clinical care studies that were more interactive with participants generally had higher retention rates. For example, three highly interactive (≥weekly text message reciprocal interaction) diabetes self-management studies had 100%, 100%, and 98% participant retention rate, respectively.[166,181–183] Another highly interactive pre-post pilot study for hypertension management in diabetic patients had a 94% retention rate.[166,184] A moderately interactive (<weekly, but ≥monthly text message reciprocal interaction) randomized controlled trial for asthma self-management had 100% participant retention[166,185] and two moderately interactive diabetes self-management studies reported retention rates of 85% and 72%, respectively.[166,186,187] A pre-post study in bulimia nervosa outpatient care with low interactivity (<monthly text message reciprocal interaction) reported a participant retention rate of only 43%[166,188] and a randomized cluster comparative trial with no reciprocal interactivity (messages were delivered but no responding text messages were received) had a 64% retention rate.[166,189] Based on these examples, higher levels of interactivity may lead to greater participant retention in text message-based interventions.

Compared to clinical care studies, preventive health behavior studies have reported less consistent rates of participant retention. For example, two highly interactive smoking cessation studies reported participant retention of only 74% and 67%, respectively.[166,190,191] Two moderately interactive randomized controlled trials (one for weight loss and the other for physical activity) had 76% and 100% participant retention, respectively.[166,192,193] However, a moderately interactive pre-post study in anti-obesity behavior modification reported only 47% retention[166,194] while the moderately interactive randomized pilot evaluation study of the

text4baby program for prenatal and infant health reported a 73% retention rate.[167] Differences in rates may have been influenced by study design, area of study, or level of participant-researcher interactivity.

Table 2.1. Participant retention rates in text message-based interventions

Study	Behavior	Study design[a]	Participant retention	Interactivity level[b]
Preventive health behavior studies				
Rodgers (2005)[191]	Smoking cessation	RCT	74%	High
Obermayer (2004)[190]	Smoking cessation	Pre-post pilot	67%	High
Hurling (2007)[192]	Physical activity	RCT	100%	Moderate
Joo (2007)[194]	Anti-obesity behavior modification	Pre-post	47%	Moderate
Shapiro (2012)[193]	Physical activity	RCT	76%	Moderate
Evans (2012)[167]	Prenatal and infant health	Randomized pilot evaluation	73%	Moderate
Clinical care studies				
Franklin (2006)[181]	Diabetes self-management	RCT	98%	High
Rami (2006)[183]	Diabetes self-management	Randomized crossover	100%	High
Kollman (2007)[182]	Diabetes self-management	Pre-post pilot	100%	High
Logan (2007)[184]	Hypertension self-management in diabetic patients	Pre-post pilot	94%	High
Kwon (2004)[187]	Diabetes self-management	Pre-post	72%	Moderate
Kim (2007)[194]	Diabetes self-management	RCT	85%	Moderate
Ostojic (2005)[185]	Asthma self-management	RCT	100%	Moderate
Robinson (2006)[188]	Bulimia nervosa outpatient care	Pre-post pilot	43%	Low
Marquez (2004)[189]	Hypertension medication compliance	Randomized cluster comparative	64%	None

[a]RCT: Randomized controlled trial

[b]High interactivity: ≥weekly text message reciprocal interaction; moderate interactivity: <weekly, but ≥monthly text message reciprocal interaction; low interactivity: <monthly text message reciprocal interaction; none: messages were delivered but no responding text messages were received

Note. Adapted from "Behavior Change Interventions Delivered by Mobile Telephone Short-Message Service," by B.S. Fjeldsoe, A.L Marshall, and Y.D. Miller, 2009, American Journal of Preventive Medicine, 36, pp. 167-169. Copyright 2009 by Elsevier. Adapted with permission.

Health behavior theories

The rapid development of mobile technologies is subsequently advancing the breadth of tools available for mHealth interventions. But, as new ways of delivering mHealth interventions arise, the development of health behavior theories may also need to evolve in order to better fit newer non-traditional methods.[195]

Based upon behavioral theory, text messaging can be an effective tool for self-monitoring due to its supportive and immediate feedback capabilities for behavioral change.[160] Social cognitive theory strategies, such as positive reinforcement, have been associated with good acceptability and adherence to the interventions.[158,160]

However, interventions using mobile technologies have not been consistently built upon health behavior theories.[195] In a systematic review of mobile device health behavior interventions published through June 2010, Riley et al identified 12 studies for weight loss, diet, and/or physical activity representing a range of interactivity.[195] Of these 12 studies, seven indicated a theoretical basis for the intervention with social cognitive theory being primary and the theory of planned behavior, self-regulation theory, and self-efficacy theory cited once each.[195] In addition, very few studies comprehensively evaluate theoretical components involved in mobile interventions.[195–198] Therefore, more research is needed to refine theories used specifically in mHealth, and it is important for researchers to incorporate, evaluate, and report the theories used in their interventions.[197] Behavior change is not straightforward and novel methods of intervention alone are not enough to change behavior; therefore, theories should always guide mobile interventions.[195]

Previous studies in nutrition using text messaging

Text message-based interventions have been used in various areas of health, including smoking cessation, disease management, appointment reminders, physical activity, weight management, and nutrition.[195] For example, in the area of nutrition, texting repeated messages has been shown to be an effective and acceptable method for increasing nutrition knowledge in college students.[157] Another study aimed at improving health behaviors in children found that their intervention increased the consumption of fruits and vegetables compared to the control group.[158] A study in children using text messaging to record nutrition and other health-related

behaviors and to deliver automated feedback found that text messaging may be a useful tool for self-monitoring.[160] An intervention aimed at increasing knowledge of recommended daily intake of calories in diners at the Johns Hopkins Cobblestone Cafe in Maryland reported that weekly text messages were more successful at increasing knowledge in comparison to the control group who did not receive any messages.[179] Finally, an assessment of the text4baby mobile health program, a text messaging service that delivers information to pregnant and new mothers to improve prenatal and postpartum care, reported positive results in changing specific beliefs such as improving the likelihood that pregnant women believed they were prepared to be new mothers.[167]

Text message-based interventions in infant health

Studies using text messaging in infant health have been few. One study conducted in Mongolia delivered infant feeding information via text messages to mothers of infants and reported a significantly lower prevalence of stunting, overweight and obesity, and anemia in the intervention group at six months old.[199] Another study in low-income adolescents in Michigan used text messaging along with other social media methods to deliver infant feeding information to improve infant weight.[200] A study that sent weekly automated text messages to BF women found that the intervention improved exclusive BF duration.[201] Finally, one study in low-income families used text message reminders to improve adherence to the infant immunization schedule.[202]

Assessing feasibility and acceptability of text message-based interventions

In addition to being an effective health prevention strategy,[203] several studies have reported that text message-based interventions are also feasible and acceptable to participants.[157,159,167,204,205] For example, one study found that relevancy of content and times of delivery may be two key aspects of successful text messages.[178] Another study reported that conducting focus groups to inform design of the text messages may not be helpful because significant differences may exist between what people think they want in a text message and what they actually experience.[178] Therefore, examining the acceptability and feasibility of text message-based interventions can contribute helpful information for mHealth strategies.

Moreover, there is a need to better understand the acceptability of text message-based interventions specifically in infant outcomes related to childhood obesity prevention.

Limitations of text messaging

One of the main reasons that text messaging is widely used in mHealth interventions is its simplicity. However, problems could occur if text messages become blocked or repeatedly bounce back from a participant's phone. Also, it is often not possible to determine if text messages were opened and read by participants.[157] However, these challenges can be mitigated by keeping detailed records of all correspondence and by promptly communicating with participants to resolve any technical issues. Other problems may arise if participants do not own mobile phones or do not have texting capabilities. However, this is most likely not a significant problem for the majority of people in the US.[161,193]

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CHAPTER 3. ACCEPTABILITY OF A TEXT MESSAGE-BASED INTERVENTION FOR OBESITY PREVENTION IN INFANTS FROM HAWAIʻI AND PUERTO RICO WIC

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Abstract

Background: Low-income and minority children, such as many of those participating in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) in Hawai‘i and Puerto Rico, are at increased risk for obesity. Text messaging offers many advantages for delivering educational information, but there have been few studies that have assessed the acceptability of text messaging in interventions aimed at preventing excessive weight gain in infants.

Aim: This study investigated the acceptability of a text message-based intervention for prevention of excessive weight gain in infants from Hawai‘i and Puerto Rico WIC clinics.

Materials and Methods: The four-month text message based intervention designed to improve infant feeding practices and to reduce excessive infant weight gain was a randomized controlled trial that included mothers with infants ages 0-2 months at baseline. Participants in the intervention arm received 18 text messages focused on reinforcing WIC breastfeeding messages and appropriate complementary feeding practices. Participant retention, satisfaction, and evidence of behavior change were assessed using qualitative and quantitative methods. Participants were asked to respond to quantitative questions on acceptability sent via text. In-person interviews were conducted at the end of the intervention period, and the final analysis for this study included 80 mother-infant pairs from the intervention arm.

Discussion: When asked about messages liked and disliked the most, most participant responses via text message indicated that they liked all messages. From the qualitative analyses, the majority of participants reported that all messages were useful and that the messages led them to make changes in the way they fed their infants. Participant retention was good at 78.4%.

Conclusions: The intervention was acceptable to participants based upon participant retention, measures of satisfaction, and reports of behavior change. These results may be used to inform the development of mobile health programs for childhood obesity prevention.

Introduction

Low-income and minority children are especially at risk for obesity,[1] with Hispanic children having increased odds of rapid infancy weight gain[2] and Native Hawaiian or Other Pacific Islander (NHOPI) children having higher body mass index (BMI) early in life.[3] In the US, 40% of low-income one-year-olds and 30% of two to five-year-olds participating in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) were overweight or obese in 2014.[4,5] Early intervention to support optimal weight gain, therefore, may be especially beneficial in these groups.

Within the first six months, infants experience a period of critical growth during which metabolic programming occurs, which may influence susceptibility to obesity later in life.[6–8] Rapid weight gain during the first two years is associated with higher BMI, greater percentage of body fat, and more total fat mass,[9] as well as other problems later in life, such as overweight, obesity, high blood pressure, and diabetes.[10–13]

Breastfeeding is protective against obesity,[6,14] with more protection conferred as exclusivity and duration of breastfeeding increases.[15] Early discontinuation of breastfeeding and early introduction of solid foods is associated with excessive weight gain.[2,16] Currently, the US breastfeeding rate at six months is below the Office of Disease Prevention and Health Promotion's Healthy People 2020 goal of 60.6%,[17] and in some locations the rate is especially low, such as in Puerto Rico at 38.1%.[18] Therefore, there is a continued need to promote and support appropriate breastfeeding practices.

Infant health studies using text messaging to deliver infant feeding information have reported significantly lower prevalence of stunting, overweight and obesity, and anemia in infants at six months old[19] and improved exclusive breastfeeding duration.[20] Other studies have used text messaging to improve infant weight[21] and to improve adherence to the infant immunization schedule.[22] However, there have not been many text message-based studies aimed at preventing childhood obesity.

Text message-based interventions for health promotion and disease prevention deliver educational information, reminders, questions, tips, and other correspondence via text messages. Mobile phones are useful tools to use in health interventions because of their increasing popularity, their ease of usability, and people's tendency to always carry them.[23] Mobile health

(mHealth) programs are potentially more effective than traditional face-to-face interventions, which are more labor intensive, time consuming, and expensive.[24] In fact, text messaging is the least expensive and most widely used technology in mHealth.[25] Text message-based interventions offer convenience for participants through instant yet asynchronous communication[26] and studies have shown that they are non-invasive and not annoying.[27–29] Demographically, certain minority groups, those with lower household income, and those with lower levels of completed education were reported to text more than other groups,[30] indicating that text message-based interventions may be most effective in these groups.

Mobile technology may also help to increase participant retention in studies. For example, a health behavior study reported that children in the text message group had better participant retention (72%) in comparison to the non-technology (39%) and control (50%) groups, and significantly greater adherence (43%) to self-monitoring in comparison to the non-technology (19%) groups.[31] Some nutrition studies utilizing text messaging have reported excellent participant retention rates ranging from 80-97%.[32–34] Moreover, participant retention has been commonly used in studies to assess acceptability.[35]

Assessing acceptability is a necessary component in determining the effectiveness of an intervention.[35] For example, a study on acceptability and program development for a mobile phone depression prevention intervention for adolescents reported findings regarding participation rates, how well participants liked the messages, usefulness of the messages, and aspects of behavioral change.[36] Text message-based interventions have been shown to be well accepted in many nutrition studies;[27,37,29,31] however, not many infant health studies have assessed acceptability of the interventions.

Assessing acceptability of text message-based interventions contributes to the improvement of mHealth intervention designs. The objective of this study was to determine the acceptability of a text message-based intervention for obesity prevention in infants from lower socioeconomic backgrounds in Hawai‘i and Puerto Rico using qualitative and quantitative methods to assess participant retention, satisfaction, and evidence of behavior change. Major themes regarding the usefulness of the text messages and how participants were influenced to change behaviors were investigated, and messages liked the most and least were determined.

Materials and Methods

Participants

The four-month text message-based intervention was designed to improve infant feeding practices and to reduce excessive infant weight gain. Mother-infant pairs participating in WIC in Hawai‘i and Puerto Rico were recruited. Infants were 0-2 months at baseline. Eligibility criteria for mothers/caregivers included the following: at least 18 years old, owned a mobile phone with unrestricted texting capabilities, responsible for caring for the infant, willing to complete the entire study, and ability to read. Additionally, inclusion criteria required the infant to have been no more than two months old at baseline, to have been born after 37 weeks of gestation, to be on a normal diet and free from disabilities that hinder movement, and to have had birthweight at or between the 10th and 90th percentiles as indicated by the World Health Organization (WHO) growth charts.[38] A convenience sample was recruited from four WIC clinics in Hawai‘i and two WIC clinics in Puerto Rico from January to April 2016. Research assistants coordinated with WIC staff to be present at the clinics during times when potential participants were scheduled for infant WIC appointments. Research assistants approached potential participants and other women with infants in the waiting area and asked them if they would be interested in taking part in the study. If interested, prospective participants were administered a questionnaire verbally to determine eligibility. Study procedures were approved by the institutional review boards at the University of Hawai‘i at Mānoa and the University of Puerto Rico, Medical Sciences Campus. Written informed consent was obtained prior to data collection. Additional details about methods and outcomes for the trial have been published elsewhere.[39]

One hundred participants in Puerto Rico and 102 participants in Hawai‘i were recruited and randomized to the control (n=100) or intervention (n=102) groups. Ninety-two participants in Puerto Rico and 78 in Hawai‘i completed the study.

Intervention design

To send and receive messages, EZ Texting, a third-party web-based text messaging platform, was used as the Internet gateway. Text messages were added to the EZ Texting study account and the day/time schedule upon which messages were sent to participants were set up prior to the start of the study. Upon enrollment, participants were sent a test text message to

confirm that a proper connection was established, after which automatic delivery of messages commenced. The server documented all text message correspondence with participants, including information regarding successful delivery of messages. Messages in Hawai‘i were sent in English and messages in Puerto Rico were written in Spanish. Prior to the study, some of the messages were pre-tested with five women in Puerto Rico, who all reported that the utility and frequency of the messages were excellent.[40]

Intervention implementation

Participants were assigned to control or intervention groups by block randomization.[41] Intervention group participants were subdivided into intervention-lactation or intervention-formula subgroups based upon lactation status at baseline. Participants in the intervention group who were breastfeeding or pumping milk were placed in the intervention-lactation subgroup. Participants' cell phones were registered into the appropriate EZ Texting protocol at baseline.

Over the course of four months, participants received 18 text messages sent on varying days and times, at a frequency of one message per week. Participants were informed they could send comments or questions back if desired. Approximately the first half of the intervention group messages focused on reinforcing WIC breastfeeding messages, with the remainder of messages focused on complementary feeding practices such as preventing overfeeding, delaying introduction of solid foods, and reducing juice consumption. Participants in the control group received messages according to the same schedule as the intervention group. Control group messages focused on general infant care unrelated to nutrition, such as sleeping position, the immunization timeline, the proper use of car seats, and other health-related information.

Data pertaining to participant contact information, date/time text messages were sent or received, and delivery status of messages were documented automatically on the online EZ Texting account. However, the system was unable to detect if messages were opened/read by participants.

Follow-up visits were conducted in person four months after the participant's baseline visit. Measures from the baseline visit were repeated and participants in the intervention group completed an interview during which qualitative data regarding acceptability of the study was collected. At the end of the visit, participants were compensated with a $50 gift card.

Measures

The baseline assessment included questionnaires and infant anthropometric measurements. Data collected from the questionnaires included the following: socio-demographic information such as race, mother's age, and infant's gender; pregnancy- and health-related information such as maternal pregravid weight and height, weeks of gestation at delivery, weight gained during pregnancy, and infant vaccinations; food frequency information; and infant feeding practices information such as breastfeeding initiation and duration, reasons for discontinuing breastfeeding, and complementary foods used. Infant weight and length were measured in duplicate by trained researchers and WIC employees at baseline and follow-up using Doran infant pan scales (model DS4100) and Easy Glide Bearing Infantometers (Perspective Enterprises, PE-RILB-BRG2) provided by the WIC clinics. Weight was measured with light or no clothes, no shoes, and a clean diaper.

During the intervention but separate from the main text messages, participants were sent seven short quantitative questions approximately every other week, starting after the second week, and were told that these text messages required a response. Two questions, "Which text message did you like the most so far?" and "Which text message did you like the least so far?" were analyzed. Responses to the other quantitative questions were reported elsewhere.[39]

During the follow-up visit, participants in the intervention arm completed qualitative interviews regarding helpfulness of the messages, problems with receiving messages, ways in which receiving the messages influenced or changed feeding practices, and overall feelings about receiving the messages. Interviewers were trained in techniques and protocol by the principal investigators. Responses were handwritten by the interviewers and later transcribed. Participants were asked six open-ended questions and were encouraged to elaborate on answers. Responses to the following three qualitative questions were analyzed: "Thinking back on the messages you were sent, which text messages were the most useful to you in feeding your infant? Why?", "Thinking back on the messages you were sent, which text messages were the least useful to you in feeding your infant? Why", and "Were there any messages that led you to feed your baby in a certain way, or make changes in what you might normally do? If so, which ones (text messages) were these, and how did they influence the way you feed your baby?" Responses to the other three qualitative questions are reported elsewhere.[39]

Figure 3.1 describes inclusion in the analysis group. Eighty participants from the intervention group completed the follow-up visit and qualitative interview. Twenty-two participants from the intervention group were lost to follow up: Hawai‘i (n=15) and Puerto Rico (n=7). Details explaining reasons participants were lost to follow-up were published previously.[39]

Qualitative data analysis

Content analysis was used to analyze qualitative data and report on themes from participant responses. Transcribed interviews were entered into NVivo Pro for Windows (QSR International, Inc., Burlington, MA) by two coders, one in Hawai‘i and one in Puerto Rico. A shared codebook was developed prior to coding and was updated during coding. Inter-rater reliability was tested prior to coding using four transcripts until a kappa value of 0.95 was achieved between coders.[42] Each coder completed coding for all transcripts at his/her site. Then, coders independently identified themes by examining frequencies of codes. Via conference call, results were compared and discussed until agreement was reached.

Statistical analyses

For baseline characteristics, descriptive statistics were presented using frequencies and percentages, or using means and standard deviations. Chi-squares tests, Fisher's exact tests, and two-sample t-tests were conducted to investigate the differences in characteristics between the final analysis group and the group that was lost to follow-up. For all analyses, a p-value of <0.05 was considered statistically significant. Analyses were performed using SAS University Edition (SAS Institute Inc., Cary, NC).

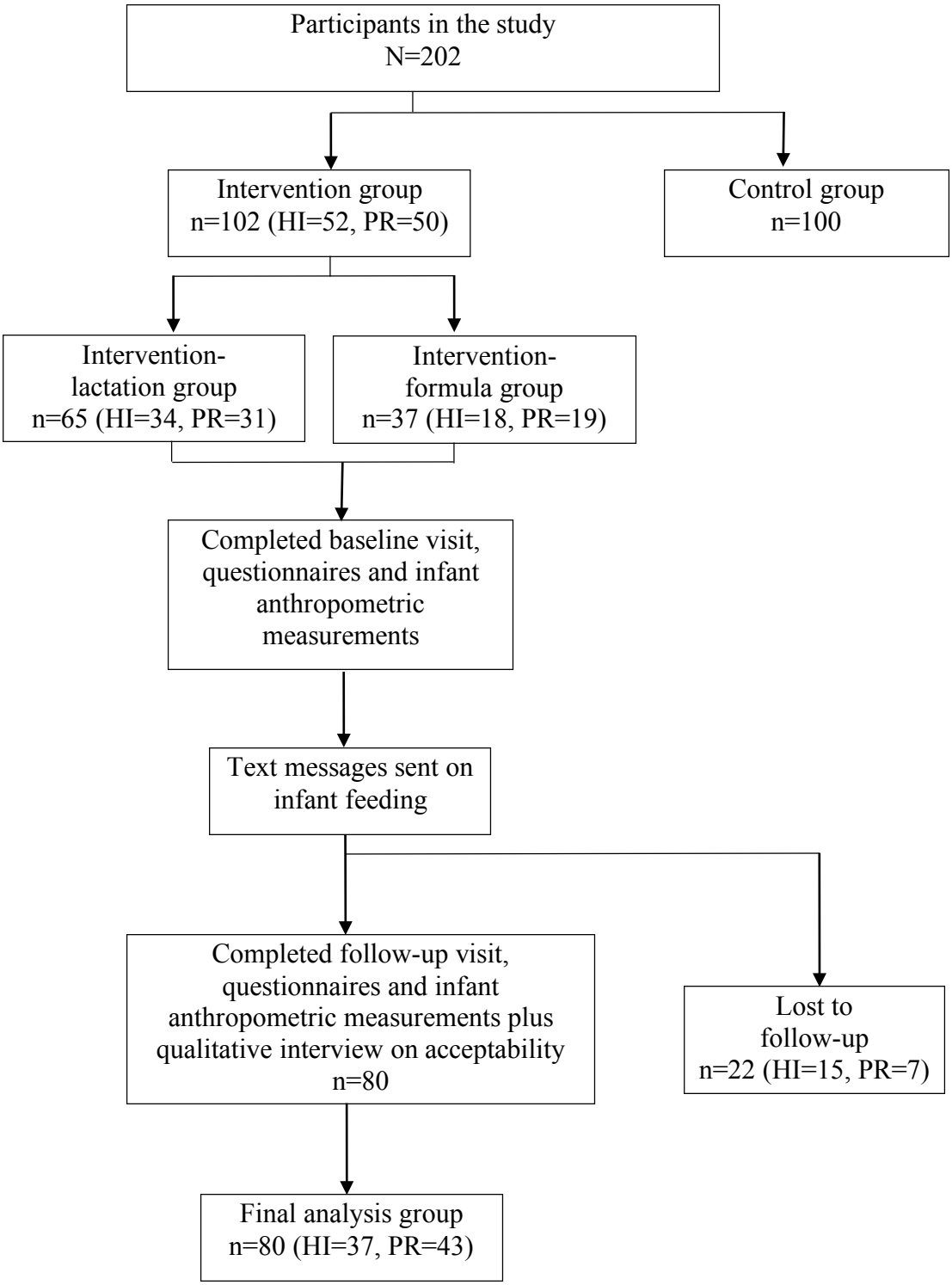

Figure 3.1. Intervention outline and inclusion in the final analysis group (HI: Hawai‘i; PR: Puerto Rico)

Results

Thirty-seven participants (46.3%) from Hawai‘i and 43 participants (53.8%) from Puerto Rico were included in the final analysis. Characteristics of the intervention group, final analysis group, and group that was lost to follow-up are shown in Table 3.1. Comparing participants in the final analysis group (n=80) with those who did not complete the study (n=22), no statistically significant differences were found for site, pregravid BMI, education, race/ethnicity (other than White), parity, pregnancy complications (such as diabetes, hypertension, or anemia), infant gender, being up-to-date with vaccines, taking vitamins while breastfeeding, maternal age (as a continuous variable), gestational age at birth, or gestational weight gain. Women who were White (p=0.04) were less likely to have been lost to follow-up. In comparison to women in age group 25-31 years, women aged 18-24 years and women aged 32 years and older were more likely to be lost to follow-up (p=0.02). Participant retention was 78.4%.

Quantitative analyses

Results from text messaged questions regarding which messages participants liked the most and the least are reported in Table 3.3 and Table 3.4, respectively. Participants responded via text message, and most indicated that they liked all messages the most (n=8). Thereafter, participants in Hawai‘i most enjoyed the text messages about offering breastmilk in a bottle or cup (n=2) and breastfeeding often during growth spurts (n=2), while participants in Puerto Rico most enjoyed the educational information about starting (n=7) and implementing (n=4) solid food feeding. Most respondents indicated that they liked all messages when asked about which message they liked the least (n=12). Thereafter, the least enjoyed text message among responding participants pertained to starting solid food feeding (HI=1; PR=1).

Qualitative analyses

Results from in-person interview questions on acceptability with exemplifying quotations are presented in Table 3.5, Table 3.6, and Table 3.7. Themes are reported in order of prominence, according to coding frequencies.

Participants expressed that messages that delivered previously unknown information or that were remindful were the most useful in feeding their infants (n=15). Thereafter, participants

indicated that all messages (n=14) and messages about breastfeeding techniques (n=14) were most useful for feeding.

Regarding which messages were the least useful for feeding, the majority of participants reported that all messages were useful (n=43). Other responses indicated that breastfeeding messages were not useful to participants who were not breastfeeding (n=12) and that breastfeeding messages were not useful if participants already knew the information (n=7).

Most participants reported that the messages led them to make changes in the way they fed their infants, such as by applying correct breastfeeding techniques (n=10), talking to their infant during feedings and observing hunger cues (n=6), and waiting to start solid foods (n=6). However, some participants reported that they made no changes in feeding (n=15) or that they already knew the information (n=6).

Discussion

Sekhon et al proposed that acceptability is based on emotional and cognitive responses to the intervention and could be assessed prior to or after the intervention.[35] Furthermore, reviews of studies have reported that participant retention or satisfaction measures are often used as proxies for acceptability.[35,43,44] Assessed at the end of the intervention, acceptability, as indicated by participant retention (78.4%), satisfaction, and behavior change, was good in the current study. Satisfaction was evidenced by most participants liking all the messages and finding all messages useful in feeding their infants. Participants also indicated that the messages were successful in changing behaviors as most participants stated that they adjusted their feeding practices. This finding is in line with other text message-based intervention studies that have reported text messaging is effective in behavioral change.[25–28]

According to the theoretical framework of acceptability (TFA), acceptability is represented by seven factors: participants' feelings about the intervention (affective attitude); the amount of effort required to participate (burden); ethicality; extent that benefits, profits, or values are sacrificed to participate (opportunity cost); perceived effectiveness; self-efficacy; and intervention coherence.[35] Based upon this definition of acceptability, the current study has investigated the construct of affective attitude in responses about liking the messages and the construct of perceived effectiveness in behavioral changes that were made by participants in

response to messages. Evidence of acceptability for this intervention which support other constructs of the TFA were reported previously: convenience was cited most as what participants liked about the intervention (burden); most participants reported no problems in participating (self-efficacy and intervention coherence); and participants most frequently reported enjoying the experience (ethicality).[39] Therefore, the current study offers further evidence of the acceptability of the intervention and presents insight into which messages were most and least useful in feeding.

Improvements could be made to the intervention. For example, future studies may consider only delivering breastfeeding messages to the formula-feeding group during the first several weeks since they were second most cited as the least useful messages for those who were not breastfeeding. Instead, more messages pertaining to formula and solid food feeding may be more useful in this intervention arm. Also, it may be beneficial to have another set of messages specific for the needs of relactating mothers who decide to start breastfeeding after starting the intervention and reading the text messages. At the baseline visit, mothers in the formula group could be informed that they can notify researchers by texting if they start breastfeeding. At that time, mothers would receive messages specific to relactation since their needs differ from women who have not had a break in lactation.[45] The current study did not inquire about relactation in the formula group, so the prevalence of this is unknown.

As markers of acceptability, satisfaction measures and participant retention may be confounded by other factors, such as incentives or accessibility of the intervention site.[35,43] Therefore, it may be important to also assess anticipated acceptability prior to the intervention, which would allow researchers to modify aspects of the intervention for greater acceptability and participation.[35] Moreover, conducting assessments before and after the intervention allows for a more comprehensive view of acceptability.

Limitations of the study

The current study has several limitations. Due to the capabilities of the EZ Texting server, once a text message question was delivered, participants were allowed to respond for the following 12 hours only. After the 12-hour window, the server did not record responses. The number of responses to the two text questions investigated in this study was low (HI: 37.8%; PR:

27.9%) but it is possible that additional delayed responses were not recorded by the server. Similarly, some messages were categorized by the server as "sent-awaiting confirmation" as some phone carriers did not allow delivery status to be known. In these cases, to ensure that participants were receiving the messages, research staff monitored participants' activity and contacted them if "sent-awaiting confirmation" appeared repeatedly. Messages that were categorized as "bounced" were resent and the participant was contacted if bounced messages occurred repeatedly. In Puerto Rico, a problem requiring an additional server for two popular phone carriers caused four participants to receive only 28-67% of messages. Finally, some participants (n=26) were not reachable for the follow-up visit despite efforts to contact them by phone call, text message, email, or voicemail.

Conclusion

Reflected by participant retention, measures of satisfaction, and reports of behavior change, the text message-based intervention was found to be acceptable. These results may be used in the further development of text message-based interventions and may inform strategies for childhood obesity prevention. For example, these results could contribute to the development of new mHealth programs at WIC clinics aimed at educating mothers about breastfeeding and other feeding practices.

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Table 3.1. Distribution of select maternal and infant characteristics, n (%), for the groups in the text message-based intervention acceptability study

	Total intervention (n=102)	Final analysis (n=80)	Lost to follow-up (n=22)	p-value
Site				0.068[a]
Hawai‘i	52 (51.0)	37 (46.3)	15 (68.2)	
Puerto Rico	50 (49.0)	43 (53.8)	7 (31.8)	
Maternal factors				
Pregravid BMI (mean [SD])	26.6 [6.9]	26.7 [7.1]	26.4 [6.0]	0.873[d]
Age (mean [SD])	26.9 [5.3]	27.0 [5.0]	26.5 [6.4]	0.688[d]
Age group				0.024[b]*
18-24 years	42 (41.2)	30 (37.5)	12 (54.6)	
25-31 years	38 (37.3)	35 (43.8)	3 (13.6)	
32-39 years	22 (21.6)	15 (18.8)	7 (31.8)	
Race[c]/ethnicity				
Hispanic	62 (62.0)	52 (65.0)	10 (50.0)	0.216[a]
Native Hawaiian or Other Pacific Islander	22 (21.6)	17 (21.3)	5 (22.7)	0.881[a]
Asian	22 (21.6)	16 (20.0)	6 (27.3)	0.463[a]
American Indian or Alaska Native	5 (4.9)	5 (6.3)	0 (0)	0.582[b]
Black or African American	15 (14.7)	14 (17.5)	1 (4.6)	0.181[b]
White	34 (33.3)	31 (38.8)	3 (13.6)	0.039[b]*
Education				0.449[b]
Less than college	49 (49.5)	38 (47.5)	11 (57.9)	
Some college	22 (22.2)	20 (25.0)	2 (10.5)	
College degree or higher	28 (28.3)	22 (27.5)	6 (31.6)	
Parity				0.126[b]
1	41 (40.2)	28 (35.0)	13 (59.1)	
2	36 (35.3)	32 (40.0)	4 (18.2)	
3	15 (14.7)	11 (13.8)	4 (18.2)	
4 or more	10 (9.8)	9 (11.3)	1 (4.6)	
Use of prenatal vitamins	97 (95.1)	78 (97.5)	19 (86.4)	0.066[b]
Pregnancy complications	43 (42.2)	32 (40.0)	11 (50.0)	0.400[a]
Took vitamins while breastfeeding	58 (56.9)	47 (58.8)	11 (50.0)	0.463[a]
Gestational age (weeks; mean [SD])	39.0 [1.1]	39.1 [1.1]	38.8 [1.1]	0.426[d]
Gestational weight gain (lb; mean [SD])	27.7 [11.2]	27.6 [11.1]	28.5 [12.1]	0.749[d]
Infant factors				
Male	51 (50.0)	39 (48.8)	12 (54.6)	0.630[a]
Female	51 (50.0)	41 (51.3)	10 (45.5)	
Up-to-date with vaccinations	87 (85.3)	68 (85.0)	19 (86.4)	1.00[b]

Note: Column percentages; p-value represents final analysis vs lost to follow-up; *p<0.05; [a]Analysis by Chi-square test; [b]Analysis by Fisher's exact test; [c]Includes all races for mixed participants; [d]Analysis by t-test, pooled

Table 3.2. Delivery schedule and text message questions regarding acceptability of the text message-based intervention

Week delivered	Message (English)	Message (Spanish)
4	Thinking about how often you get text messages about feeding your baby, would you like to receive them: Less often, As often, or More often? Pls txt response	Pensando en la frecuencia que recibió los mensajes, le gustaría recibirlos: Menos frecuente, Igual de frecuente, Más frecuente
6	Were the times of days you received the text messages OK? Reply: Yes or No. If no, suggest a time please.	Hasta ahora, le ha parecido que la hora en que le hemos enviado los mensajes esta bien? Responda: SI o NO. En caso de NO, sugiera una hora por favor.
8	Did you find receiving text messages about feeding your baby helpful? Reply: Yes or No	¿Le han sido de ayuda los mensajes sobre la alimentación de su bebé?: Responda: SI o NO.
10	Did you find receiving text messages about feeding your baby irritating, annoying? Reply: Yes or No	¿Los mensajes sobre la alimentación de su bebé le han molestado o fastidiado? Responda: SI o NO.
12	Were the text messages about feeding your baby easy to understand? Reply: Yes or No	¿Le ha parecido fácil de entender los mensajes sobre la alimentación de su bebé? Responda: SI o NO.
14	Which SMS did you like the most so far?	¿Cual mensaje le ha gustado más hasta ahora?
16	Which SMS did you like the least so far?	¿Cual de todos los mensajes enviados en el estudio le gusto menos?

Note: SMS=short message service (text message)

Table 3.3. Responses from participants in week 14 regarding which message they liked the most in the text message-based intervention

Week delivered	Message	Number of participants: Puerto Rico (n=15)	Number of participants: Hawai‘i (n=17)
2	When breastfeeding, make sure the nipple and the area around is inside baby’s mouth. If baby eats from the tips, they will crack. Always correct the position.	1	
3	Breastfeeding is the best way to feed your baby, but it may be hard. Put your baby to your breast and you will have more milk. Ask for help.		1
6	Breastfeed your baby from the same breast until it feels empty. That way, your baby gets the fat that comes at the end and will be full longer.		1
8	Your milk is the best food for baby for the first 6 months of life. If you cannot put your baby directly to your breast, you can give it in a bottle or cup.		2
8	You can tell if you have enough milk by counting wet diapers. Your baby should have 6 or more wet diapers every day after the 4th day of birth.		1
9	Babies have growth spurts and want to breastfeed often, which increases hunger. Your baby will drink more to increase your milk for 3 days. This is normal.		2
10	If you give milk in a bottle, do not add other foods such as baby cereal or baby food. If your baby seems full, do not force him/her to finish it.	1	1
13	Prepare your milk stock by extracting milk at the end of every feeding and put it in the fridge in a clean bottle. At the end of the day you will have 2-3 oz.	1	1
14	Do not put your baby to sleep with the bottle or cup. The milk residue can lead to cavities and to excess weight.		1
15	Your baby is ready to eat when he/she sits on his/her own, opens his/her mouth, chews and leans toward foods. Wait until 6 months to start feeding other foods.	7	
16	When your baby is 6 months, you can give meat, cereals with iron, or vegetables (puree), 1 at a time and using a spoon. Wait 3 days before giving a new food.	4	
NA	All messages	1	7

Note: NA=not applicable

Table 3.4. Responses from participants in week 16 regarding which message they liked the least in the text message-based intervention

Week delivered	Message	Number of participants: Puerto Rico (n=9)	Number of participants: Hawai‘i (n=11)
3	To start breastfeeding again, ask for help. You only can give your milk if you put your baby to your breast often to make milk.	1	
7	While breastfeeding, you do not need to eat a special diet or beverage, you only need to be hydrated. Drink 8-10 glasses of water every day.		1
11	Feed your baby when he/she moves his/her lips, sucks his/her hands and turns his/her head searching for the breast. Crying does not always mean hunger.	1	
12	If you need to work or study, extract milk every 2-3 hours to keep up your milk production. There are laws that protect you to do this.		1
13	Prepare your milk stock by extracting milk at the end of every feeding and put it in the fridge in a clean bottle. At the end of the day you will have 2-3 oz.	1	
15	Your baby is ready to eat when he/she sits on his/her own, opens his/her mouth, chews and leans toward foods. Wait until 6 months to start feeding solid foods.	1	1
18	Baby juice has sugar that babies do not need. Instead of juice, give water or fruits pureed or blended with water. This will help your baby stay healthy.	1	
NA	Like all messages	4	8

Note: NA=not applicable

Table 3.5. Coding frequencies for most prevalent themes and exemplifying quotations regarding which text messages participants (n=80) felt were the most useful in feeding their infant

Prevalent themes and coding frequencies	Explanation of theme	Exemplifying quotation
Most-feeding_knowledge (HI=9, PR=6)	Messages informed or reminded participant of feeding facts and tips.	"Choosing formula with iron was helpful because I didn't really know much about iron."
Most-all (HI=6, PR=8)	All messages were found useful.	"Yes, all the information was useful and I replied back to some of them."
Most-breastfeeding_technique (HI=7, PR=7)	Participant gained knowledge of techniques such as proper positioning, pain management, and milk production.	"I always had a hard time breastfeeding, especially getting baby latched on. So this message was a good reminder for latching."
Most-breastfeeding_knowledge (PR=12)	Messages informed or reminded participant of breastfeeding facts and tips.	"Now I have an 8-year-old son and these are things (about breastfeeding) I never knew."
Most-feeding_application (HI=8)	Messages helped participant apply proper feeding techniques and information, such as counting diapers and offering foods with a spoon.	"I used spoon to feed and watched baby's behavior to new foods like when she goes to rice cereal and opens her mouth."
Most-breastfeeding_signs (HI=7)	Messages informed participant of hunger signs that indicate when to breastfeed.	"I thought in the beginning that crying meant he was hungry, so we wasted a lot of milk trying to feed him when he wasn't hungry."

Note: HI=Hawai‘i; PR=Puerto Rico

Table 3.6. Coding frequencies for most prevalent themes and exemplifying quotations regarding which messages participants (n=80) felt were the least useful in feeding their infant

Prevalent themes and coding frequencies	Explanation of theme	Exemplifying quotation
Least-none (HI=25, PR=18)	All messages were found useful.	"All were useful in one way or another."
Least-breastfeeding_not applicable (HI=5, PR=7)	Breastfeeding information did not apply to the participant.	"Had to stop breastfeeding before 6 months due to MD's order, this message didn't apply."
Least-breastfeeding_known (PR=7)	Participants already knew the breastfeeding information.	"I already knew."

Note: HI=Hawai'i; PR=Puerto Rico

Table 3.7. Coding frequencies for most prevalent themes and exemplifying quotations regarding how messages changed the way participants (n=80) fed their infant

Prevalent themes and coding frequencies	Explanation of theme	Exemplifying quotation
Changes-none_none (HI=7, PR=8)	Participant made no changes.	"No, did not change the way I fed my baby."
Changes-breastfeeding_knowledge (PR=10)	Messages led participant to apply correct breastfeeding techniques.	"It helped me produce more breast milk with the correct technique."
Changes-feeding_talk gestures (HI=6)	Participant started talking to baby during feedings and learned to observe baby's gestures to indicate hunger.	"Knowing crying doesn't always mean hunger helped me pay more attention to baby's cues."
Changes-feeding_solid time (PR=6)	Participant decided to wait for suggested time to start feeding infant solid foods.	"Although some people told me to feed solid food to baby, I waited until 5-6 months."
Changes-none_already knew (HI=6)	Participant did not make any changes because she already knew the information.	"No, I already knew the information in the messages."
Changes-feeding_caries (HI=5)	Participant stopped putting her infant to sleep with a bottle.	"The message about putting baby to sleep with a bottle- I was doing this and then stopped doing it after reading the message."

Note: HI=Hawai'i; PR=Puerto Rico

CHAPTER 4. ASSOCIATION BETWEEN MATERNAL PREGRAVID BODY MASS INDEX AND BREASTFEEDING DISCONTINUATION IN HAWAI‘I AND PUERTO RICO WIC PARTICIPANTS

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Abstract

Objectives: This study investigated the association between maternal pregravid body mass index (BMI) and breastfeeding discontinuation at four to six months postpartum in Hawai‘i and Puerto Rico participants from the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC).

Methods: This was a secondary data analysis from a text message-based intervention in WIC participants in Hawai‘i and Puerto Rico. The analysis included 87 mothers from the control group who initiated breastfeeding and whose breastfeeding status was known at the end of the study when infants were four to six months old. Pregravid BMI and breastfeeding discontinuation were assessed using questionnaires.

Results: The association between pregravid BMI and breastfeeding discontinuation was not significant in the unadjusted model or in the adjusted model. Native Hawaiian or Other Pacific Islanders (NHOPIs) showed significantly higher odds of discontinuing breastfeeding (adjusted odds ratio [AOR]=7.12; 95% CI= 1.34, 37.97; p=0.02) compared to all other races/ethnicities, as did older women ages 32-39 years versus women who were 25-31 years old (AOR=4.21; 95% CI=1.13, 15.72; p=0.03). Women who took vitamins while breastfeeding had lower odds of discontinuing breastfeeding (AOR=0.15; 95% CI=0.05, 0.46; p=0.0009).

Conclusions for Practice: Pregravid BMI was not significantly associated with breastfeeding discontinuation at four to six months postpartum in women from Hawai‘i and Puerto Rico WIC, but NHOPIs and women who were older had higher odds of discontinuing breastfeeding. The results of this study may inform strategies for breastfeeding promotion and childhood obesity prevention but should be further investigated in larger studies.

Introduction

Although breastfeeding rates are rising in the US, where the breastfeeding rate at six months increased from 51.8% of infants in 2013 to 55.3% in 2014,[1] the US has not yet met the Office of Disease Prevention and Health Promotion's Healthy People 2020 goal of 60.6% of infants breastfeeding at six months.[2] In Puerto Rico, the breastfeeding rate at six months is low at 38.1%, which is about 17% lower than the national average.[3]

Overweight and obese women may have an increased risk for failure to initiate breastfeeding and decreased duration of breastfeeding, as indicated by a 2010 literature review.[4] Previous studies have reported negative associations between pregravid overweight/obesity body mass index (BMI) and breastfeeding duration in Hispanic[5] and White[6] women. According to the 2010 Hawai'i Pregnancy Risk Assessment Monitoring System (PRAMS) Breastfeeding Fact Sheet, obese maternal pregravid BMI is associated with less breastfeeding initiation and breastfeeding for less than eight weeks in Hawai'i's racially diverse population.[7,8]

One biological factor that likely causes overweight and obese women to stop breastfeeding is a lower prolactin response to suckling.[9] This diminished response may lead to compromised milk production and, subsequently, to premature cessation of breastfeeding.[9] Delayed lactogenesis II, or a delay in the onset of copious milk production after birth, is associated with overweight or obese BMI[10] and exhibited a significant effect on cessation of breastfeeding at four weeks postpartum in a study with almost 2,500 US women.[11]

Breastfeeding is moderately yet consistently protective against obesity later in life.[12] According to the Centers for Disease Control and Prevention (CDC), nine months of breastfeeding reduces an infant's risk of becoming overweight by more than 30%.[13] Moreover, more protection from overweight and obesity is conferred by increasing the exclusivity and duration of breastfeeding.[14] In contrast, high maternal pregravid BMI has been shown to be a significant risk factor for childhood obesity,[15] and pregravid obesity is associated with increased fat mass in newborn offspring.[16]

Low-income and minority children are particularly at risk for childhood obesity.[17] Among infants, Hispanic and Black children have increased odds of rapid infancy weight gain compared with White infants.[18] Minority groups in Hawai'i, such as Native Hawaiian or Other Pacific Islander (NHOPI), have higher BMI between two and four months of age compared to

other races.[19] In one study, low-income NHOPI and Filipino pre-kindergarten children in Hawai‘i had a high prevalence of obesity, with more than 42% being overweight or obese.[20] Nationally, in 2014, overweight or obesity occurred in 40% of US one-year-olds and 30% of two to five-year-olds participating in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC),[21] a federally funded program for low-income women and children.

For obesity prevention, the association between pregravid BMI and breastfeeding duration is worthy of attention. To our knowledge, no studies have investigated the association between pregravid BMI and breastfeeding discontinuation in low-income groups in Hawai‘i or Puerto Rico. Examination of this association may inform childhood obesity prevention strategies in these groups. Therefore, the objective of this study is to investigate the association between maternal pregravid BMI and breastfeeding discontinuation at four to six months postpartum in Hawai‘i and Puerto Rico WIC participants. We hypothesized that low-income women in Hawai‘i and Puerto Rico with pregravid BMI≥25 will have greater odds of discontinuing breastfeeding before four to six months postpartum than women with pregravid BMI<25.

Methods

Participants

A secondary data analysis was conducted using data from a four-month text message-based intervention aimed at preventing excessive weight gain in at-risk infants from WIC clinics in Hawai‘i and Puerto Rico.[22] Eligible mothers/caregivers were at least 18 years old, owned a mobile phone with unrestricted texting capabilities, were responsible for caring for the infant, and were willing to complete the entire study. Inclusion criteria required the infant to have been no more than two months old at baseline, to have been born after 37 weeks of gestation, to be on a normal diet and free from disabilities that hinder movement, and to have had birthweight at or between the 10th and 90th percentiles as indicated by the World Health Organization (WHO) growth charts.[23] A convenience sample of infants (n=202) and their mother/caregiver were recruited from four WIC clinics in Hawai‘i and two WIC clinics in Puerto Rico from January to April, 2016. Participants were assigned to control or intervention groups by block randomization. Detailed methods used in the trial have been published elsewhere.[22] Study procedures were approved by the institutional review boards at the University of Hawai‘i at Mānoa and the

University of Puerto Rico, Medical Sciences Campus, and informed consent was obtained prior to data collection.

Measures

Mothers/caregivers (n=202) completed the baseline assessment which included questionnaires and infant anthropometric measurements. Data collected from the questionnaires included the following: socio-demographic information such as race, mother's age, and infant's gender; pregnancy- and health-related information such as maternal pregravid weight and height, weeks of gestation at delivery, weight gained during pregnancy, and infant vaccinations; food frequency information; and infant feeding practices information such as breastfeeding initiation and duration, reasons for discontinuing breastfeeding, and complementary foods used.

Analyses for the current study included the control group only (n=100). Pregravid BMI (exposure) was calculated using self-reported weight before pregnancy and height. The National Institutes of Health classifications for BMI (kg/m^2) was used to determine weight status: underweight (<18.5), normal (18.5-24.9), overweight (25-29.9), and obese (≥30).[24] Breastfeeding initiation was defined as breastfeeding at least once and was assessed using the questionnaire item, "Did you breastfeed your baby, even once?" Discontinuation of breastfeeding (main outcome of interest) was assessed with the questionnaire item, "Are you still breastfeeding your baby?" Duration of breastfeeding was self-reported with the questionnaire item, "If you are no longer breastfeeding your baby, how old was your baby when you stopped nursing?" Exclusively pumping milk was considered continued breastfeeding.

Figure 4.1 describes inclusion in the analysis group. Ninety-eight participants from the control group initiated breastfeeding. Eighty-seven mothers/caregivers completed the four-month follow-up assessment. Of those who initiated breastfeeding, 11 were lost to follow-up and their breastfeeding duration could not be determined. Of those lost, seven had normal pregravid BMI, three were overweight, one was obese, nine were from Hawai‘i, and two were from Puerto Rico.

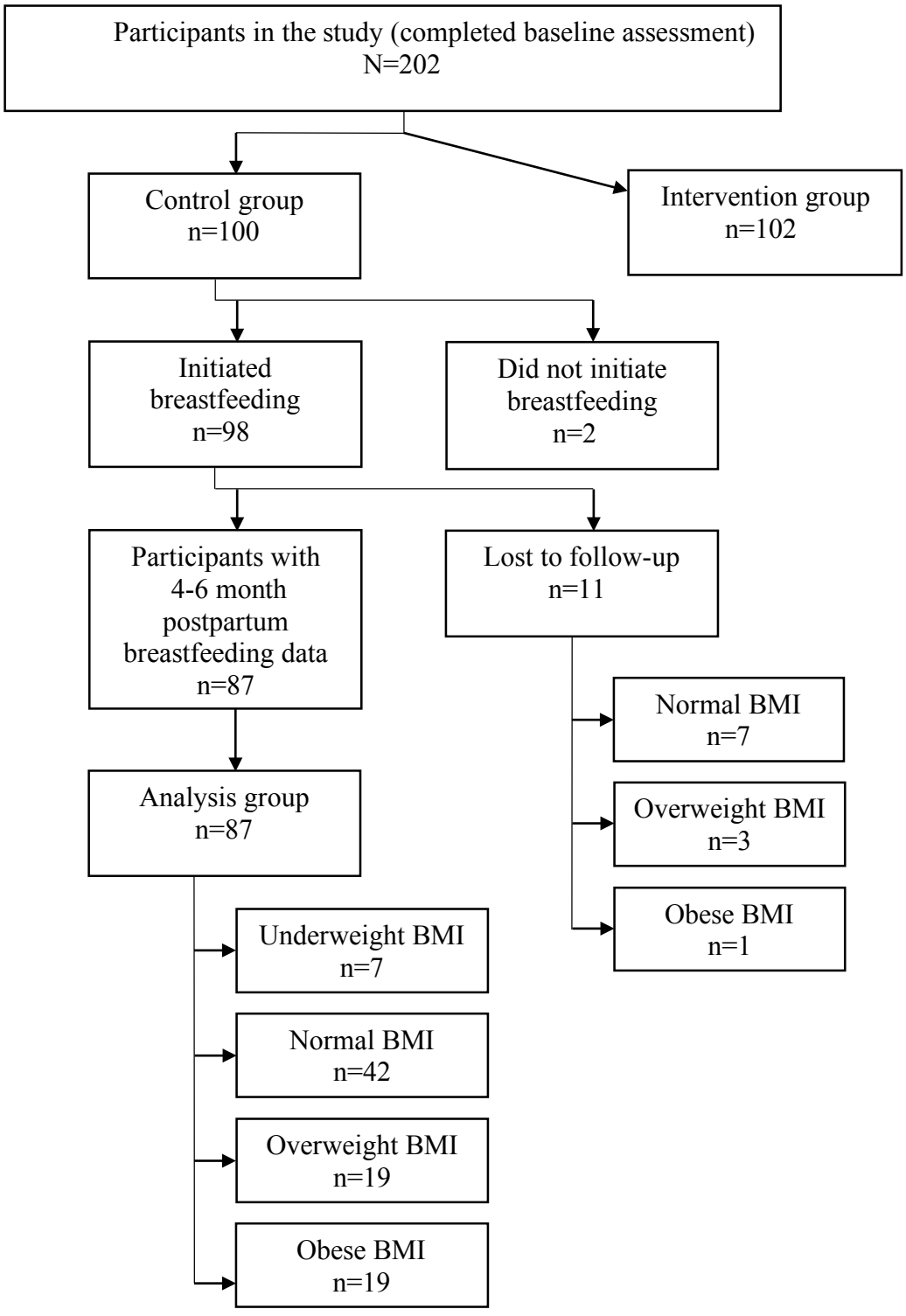

Figure 4.1. Final analysis group and participants lost to follow-up for a secondary data analysis of pregravid body mass index (BMI) and breastfeeding discontinuation

Variables

Dependent variable

Breastfeeding discontinuation status at four to six months postpartum was defined as a binary outcome in mothers from the control group who initiated breastfeeding (n=98) and whose breastfeeding status was known at the end of the study (n=87). Breastfeeding continuation was coded as "yes", and breastfeeding discontinuation was coded as "no".

Independent variable

Due to the similar trend in the distribution in breastfeeding status between pregravid BMI categories, pregravid BMI categories were combined as underweight/normal (UN) or overweight/obese (OWOB) for the analysis.

Possible covariates

Variables tested as possible covariates included site (Hawai'i or Puerto Rico), mother's race/ethnicity, mother's age (divided into three strata by years: 18-24, 25-31, and 32-39), mother's education level, parity, use of prenatal vitamins during pregnancy, pregnancy complications (such as diabetes, hypertension, or anemia), use of vitamins while breastfeeding, weeks of gestation at delivery, gestational weight gain, infant gender, and being up-to-date with infant vaccinations. Based upon the US Office of Management and Budget (OMB) standards,[25] race/ethnicity was categorized into the following groups: Hispanic, Native Hawaiian or Other Pacific Islander (NHOPI), American Indian or Alaska Native, Asian, Black or African American, and White. Each racial/ethnic group was treated as a binary variable (Yes/No).

Statistical analyses

For baseline characteristics, descriptive statistics were presented using frequencies and percentages, or using means and standard deviations. Chi-squares tests, Fisher's exact tests, and two-sample t-tests were conducted to investigate the bivariate associations between baseline characteristics and breastfeeding discontinuation status, depending on variable type. Odds ratio test was used to measure the unadjusted effect of the bivariate association between breastfeeding status (discontinuation or continuation) and pregravid BMI (OWOB or UN).

To determine the association between pregravid BMI and breastfeeding discontinuation, a multivariable logistic regression was conducted adjusting for the demographic variables that were statistically significant in the bivariate analyses. The covariates in the final logistic models were NHOPI race, mother's age, and use of vitamins while breastfeeding. Goodness-of-fit for the multivariable logistic regression model was assessed using Hosmer and Lemeshow test, and c-statistics was used to measure the accuracy of the model. For all analyses, a p-value of <0.05 was considered statistically significant. Analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NC).

Results

Forty participants (46%) from Hawai‘i and 47 participants (54.0%) from Puerto Rico were included in the final analysis. Characteristics of the final analysis group, presented by pregravid BMI, are shown in Table 4.1. Characteristics of the control group and group that was lost to follow-up are shown in Table 4.2. Comparing participants in the final analysis group (n=87) with those who did not complete the study (n=11), we found no statistically significant differences in age, gestational age at birth, gestational weight gain, pregravid BMI, race other than Asian and non-White, level of education, parity, use of prenatal vitamins during pregnancy, pregnancy complications, infant gender, and being up-to-date with infant vaccines. Women who were in Hawai‘i (p=0.05), Asian (p=0.04), non-White (p=0.02), or who took vitamins while breastfeeding (p=0.04) were more likely to have been lost to follow-up.

Half of the women in the final analysis group were in the 25-31 years old age group, half (49.4%) were White, 14.9% were NHOPI, and more than half (61.6%) were Hispanic. In the final group, almost all women (97.7%) used prenatal vitamins and about half (49.4%) used vitamins while breastfeeding. Sixty percent of NHOPI participants were overweight or obese prior to pregnancy, and 66.7% of Asian women had UN pregravid BMI. More than half (52.6%) of OWOB women had pregnancy complications in contrast to about a quarter (26.5%) of UN women having complications.

The mean pregravid BMI for the final analysis group was 26.2 (SD=7.1). Participants who discontinued breastfeeding (n=43) or continued breastfeeding (n=44) had mean pregravid BMI of 27.6 (SD=8.5) or 24.8 (SD=5.1), respectively, which was not significantly different

(p=0.07). Bivariate analysis results, shown in Table 4.3, revealed that the associations between breastfeeding status and the following variables were not statistically significant: site, pregravid BMI, age (as a continuous variable), race/ethnicity (except NHOPI vs other), level of education, parity, use of prenatal vitamins, pregnancy complications, gestational age at birth, gestational weight gain, infant gender, and being up-to-date with infant vaccines. Variables that were statistically significant were used in the final adjusted multiple logistic regression model: age by category (p=0.046), NHOPI (p=0.011), and took vitamins while breastfeeding (p<0.0001). As shown in Table 4.3, slightly more than half (53.5%) of the women who discontinued breastfeeding had normal or underweight pregravid BMI, and a little more than half (52.6%) of OWOB women discontinued breastfeeding.

As shown in Table 4.4, the association between breastfeeding discontinuation and pregravid BMI was not significant in the unadjusted model (crude odds ratio [COR]=0.8; 95% confidence interval [CI]=0.34, 1.86; p=0.60) or in the adjusted model (adjusted odds ratio [AOR]=1.34; 95% CI=0.44, 4.02; p=0.61). However, as presented in Table 4.4, participants of NHOPI race showed significantly higher odds of discontinuing breastfeeding (AOR=7.12; 95% CI=1.34, 37.97; p=0.02). Also, older women in age group 32-39 years, versus women who were 25-31 years old, showed higher odds of discontinuing breastfeeding (AOR=4.21; 95% CI=1.13, 15.72; p=0.03). Finally, women who took vitamins while breastfeeding had lower odds of discontinuing breastfeeding (AOR=0.15; 95% CI=0.05, 0.46; p=0.0009).

The Hosmer and Lemeshow test was not significant (p=0.58), and the c-statistic was 0.84 (95% CI=0.76, 0.92), indicating a good model fit.

Discussion

Several previous studies reported associations between maternal pregravid BMI and breastfeeding duration at six months in minority populations in the US,[4–6] but none investigated these associations in low-income groups in Hawai‘i or Puerto Rico. Therefore, there is need for more research in these at-risk populations, and the current study contributes new knowledge in this area.

Contrary to our hypothesis, in comparison to women with pregravid BMI<25, overweight or obese women from Hawai‘i and Puerto Rico WIC did not show higher odds of discontinuing

breastfeeding at four to six months postpartum. Larger studies have reported that overweight or obese women are more likely to breastfeed for shorter duration than normal or underweight women.[4,7] There are physiological mechanisms that support the association between OWOB pregravid BMI and early cessation of breastfeeding, such as lower prolactin response to suckling[9] and delayed lactogenesis II.[10,11] Therefore, it may be worthwhile to investigate this association in future studies with a larger sample to better understand the impact of pregravid BMI on breastfeeding practices of low-income women in Hawai‘i and Puerto Rico.

There were several statistically significant associations in the final analysis group. Older women (32 years and older) had more than four times the odds of discontinuing breastfeeding than women aged 25-31 years. One explanation for this association may be due to physiological factors related to milk production or career responsibilities that may be increased with older age. For example, it was reported that risk factors for early weaning in Hawai‘i women included problems starting breastfeeding, problems with breasts, full-time employment outside of the home, and insufficient milk.[26] It is possible that factors such as these that lead to early breastfeeding discontinuation may intensify as maternal age increases. In a breastfeeding study of blue collar Taiwanese women, women aged 30 years or older had significantly decreased odds of initiating breastfeeding than women younger than 30 years, and breastfeeding discontinuation rate increased as the number of employed years increased.[27]

Another reported risk factor for early breastfeeding discontinuation has been mother’s education level. According to the Hawai‘i PRAMS 2010 fact sheet, mother’s education level at high school or lower was associated with breastfeeding for less than two months postpartum.[7] In WIC infants in Puerto Rico, breastfeeding duration was positively associated with age of introduction of drinks other than breastmilk and caregiver’s educational level.[28] Contrary to these findings, we did not find that breastfeeding status was associated with mother’s education level. Similarly, no association was found in a previous study conducted in Hawai‘i WIC participants.[29] Of note, results of these studies may not be comparable due to the use of varying levels of education across the analyses. For example, Hawai‘i PRAMS used five levels of education,[7] the Puerto Rico WIC study used two levels,[28] and the current study used three levels of education. Future analyses could be conducted using the same classification of levels of education to further compare findings.

According to the 2010 PRAMS fact sheet, women in Hawai‘i who initiated breastfeeding but discontinued before eight weeks postpartum were more likely to be Hawaiian, Samoan, Filipino, or Black.[7] The current study found that 80% of NHOPI women discontinued breastfeeding before four to six months postpartum. In comparison to the other races/ethnicities, NHOPI women had more than seven times the odds of discontinuing breastfeeding (AOR=7.12; 95% CI=1.34, 37.97; p=0.022). However, the number of NHOPI women was very small (n=15) and the wide confidence interval suggests that a larger sample size may be needed to confirm our finding and to produce a more precise estimate of the effect. Other studies have reported lower rates for breastfeeding discontinuation in NHOPI women in Hawai‘i,[29] although, in comparison to other races, the percentages of NHOPI women who discontinued breastfeeding were higher. A small study of postpartum Native Hawaiian women in Hawai‘i enrolled in WIC during 2003-2005 reported that 48% of the women discontinued breastfeeding before six months postpartum.[29] According to the 2014 PRAMS, 28% of low-income NHOPI women in Hawai‘i who initiated breastfeeding discontinued breastfeeding before eight weeks postpartum.[30] Outside of the US, earlier studies prior to 1985 demonstrated that breastfeeding discontinuation rates for some Pacific Islander women are much lower at four to six months postpartum, ranging from just 7-14%.[31,32] More recently, in 2007, it was reported that 47% of Pacific Islanders in the Commonwealth of the Northern Mariana Islands discontinued breastfeeding before six months.[33] However, it is possible that Pacific Islanders who reside in Hawai‘i have different breastfeeding practices in comparison to those living in the Pacific Islands, and there is a need to better understand these disparities and the risk factors for poor breastfeeding outcomes in US NHOPI women.

In addition to mother’s age and NHOPI race, the use of vitamins while breastfeeding was significantly associated with breastfeeding status at four to six months postpartum. Similar factors, such as race/ethnicity and maternal age, have been covariates in other studies.[4] But, to our knowledge, the association between vitamin use while breastfeeding and breastfeeding discontinuation has not been widely reported. Women who took vitamins while breastfeeding had 85% reduction in odds of discontinuing breastfeeding (AOR=0.15; 95% CI= 0.05, 0.46; p=0.0009). One possible explanation for this association is that women who are taking vitamins while breastfeeding are getting appropriate postnatal care and are, therefore, receiving more

education and support for breastfeeding. These women may also be more inclined to seek out infant care education and to be proactive in implementing preventative measures.

Limitations of the study

There are several limitations of this study. First, there was a small sample size, which may have impeded our ability to detect statistically significant associations. Additional studies are needed to further investigate the associations described in this study. Second, our results are not generalizable to women beyond those participating in the study due to the inherent bias of convenience sampling. Third, the current BMI cut-off points may not be accurate in some populations such as Pacific Islanders[34] due to differences in body composition. However, the WHO expert consultation has recommended that the current WHO BMI cut-off points be retained as the international standard.[35] Finally, pregravid BMI was calculated using self-reported weight and height, which could have introduced measurement error.

Implications for future research and clinical practice

Early discontinuation of breastfeeding and introduction of solid foods is associated with excessive weight gain.[18] There is a continued need to promote and support appropriate breastfeeding practices. This study may inform new strategies for breastfeeding promotion and childhood obesity prevention. For example, considering the results, it may be beneficial to focus more on breastfeeding education, outreach, and support efforts on women who are older or NHOPI, rather than on those who are overweight or obese.

Conclusion

Pregravid BMI was not significantly associated with breastfeeding discontinuation at four to six months postpartum in women from Hawai‘i and Puerto Rico WIC. However, women of NHOPI race, in comparison to other races, and women aged 32 years and older, in comparison to women aged 25-31 years, had higher odds of discontinuing breastfeeding at four to six months. Compared to women who did not take vitamins while breastfeeding, women who took vitamins had lower odds of discontinuing breastfeeding at four to six months postpartum.

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Conflict of interest

The authors declare that they have no conflict of interest.

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Table 4.1. Distribution of select maternal and infant characteristics by pregravid body mass index (BMI), n (%), for the final analysis group from a secondary data analysis of pregravid BMI and breastfeeding discontinuation

	Total (n=87)	UN[a] (n=49)	OWOB[b] (n=38)
Maternal factors			
Age (mean [SD])	27.0 [5.0]	27.6 [4.9]	26.4 [5.1]
18-24 years	29 (33.3)	13 (26.5)	16 (42.1)
25-31 years	40 (50.0)	25 (51.0)	15 (39.5)
32-39 years	18 (20.7)	11 (22.4)	7 (18.4)
Race[c]/ethnicity			
Hispanic	53 (61.6)	28 (57.1)	25 (65.8)
Native Hawaiian or Other Pacific Islander	15 (14.9)	6 (8.2)	9 (23.7)
Asian	15 (17.2)	10 (20.4)	5 (13.2)
American Indian or Alaska Native	3 (3.5)	1 (2.0)	2 (5.3)
Black or African American	11 (12.6)	6 (12.2)	5 (13.2)
White	43 (49.4)	26 (53.1)	17 (44.7)
Education			
Less than college	34 (39.1)	19 (38.8)	15 (39.5)
Some college	21 (24.1)	11 (22.4)	10 (26.3)
College degree or higher	32 (36.8)	19 (38.8)	13 (34.2)
Parity (mean [SD])	1.8 [0.8]	1.8 [0.9]	1.8 [0.6]
Use of prenatal vitamins	85 (97.7)	47 (95.9)	38 (100.0)
Pregnancy complications	33 (37.9)	13 (26.5)	20 (52.6)
Took vitamins while breastfeeding	43 (49.4)	21 (42.9)	22 (57.9)
Gestational age (weeks; mean [SD])	38.8 [1.0]	38.8 [1.2]	38.8 [0.6]
Gestational weight gain (lb; mean [SD])	27.8 [12.1]	29.2 [10.6]	26.1 [13.8]
Infant factors			
Male	44 (50.6)	26 (53.1)	18 (47.4)
Female	43 (49.4)	23 (46.9)	20 (52.6)
Up-to-date with vaccinations	70 (80.5)	38 (77.6)	32 (84.2)

[a]Underweight or normal BMI; [b]Overweight or obese BMI; [c]Includes all races for mixed participants; Note: Column percentages

Table 4.2. Characteristics of control group and group that was lost to follow-up from a secondary data analysis of pregravid BMI and breastfeeding discontinuation

	Control group, n (%)	Lost, n (%)
	Total (n=100)	Total[a] (n=11)
Maternal factors		
Age (mean [SD])	27.0 [5.0]	26.6 [5.8]
18-24 years	33 (33.0)	4 (36.4)
25-31 years	47 (47.0)	5 (45.5)
32-39 years	20 (20.0)	2 (18.2)
Race[b]/ethnicity		
Hispanic	60 (60.0)	6 (54.5)
Native Hawaiian or Other Pacific Islander	17 (17.0)	2 (18.2)
Asian	20 (20.0)	5 (45.5)
American Indian or Alaska Native	4 (4.0)	0 (0)
Black or African American	12 (12.0)	1 (9.1)
White	45 (45.0)	1 (9.1)
Education		
Less than college	42 (42.0)	6 (54.5)
Some college	22 (22.0)	1 (9.1)
College degree or higher	36 (36.0)	4 (36.4)
Parity (mean [SD])	1.8 [0.8]	2.0 [1.0]
Use of prenatal vitamins	98 (98.0)	11 (100.0)
Pregnancy complications	41 (41.0)	7 (63.6)
Took vitamins while breastfeeding	53 (53.0)	10 (90.9)
Gestational age (weeks; mean [SD])	38.9 [1.0]	39.3 [1.0]
Gestational weight gain (lb; mean [SD])	27.9 [12.2]	25.9 [12.2]
Infant factors		
Male	52 (52.0)	6 (54.5)
Female	48 (48.0)	5 (45.5)
Up-to-date with vaccinations	81 (81.0)	9 (81.8)

[a]Does not include those who did not initiate breastfeeding (n=2); [b]Includes all races for mixed participants; Note: Column percentages

Table 4.3. Results of bivariate analysis by breastfeeding status from a secondary data analysis of the association between pregravid BMI and breastfeeding discontinuation

Variable	Breastfeeding status at 4-6 months, n (%)		p-value
	Discontinued 43 (49.3)	Continued 44 (50.6)	
Site			0.165[a]
Hawai‘i	23 (57.5)	17 (42.5)	
Puerto Rico	20 (42.6)	27 (57.5)	
Pregravid BMI			0.569[a]
Underweight	3 (42.9)	4 (57.1)	
Normal	20 (47.6)	22 (52.4)	
Overweight	8 (42.1)	11 (57.9)	
Obese	12 (63.2)	7 (36.8)	
Pregravid BMI (combined)			0.598[a]
Underweight or normal	23 (46.9)	26 (53.1)	
Overweight or obese	20 (52.6)	18 (47.4)	
Pregravid BMI (mean [SD])	27.6 [8.5]	24.8 [5.1]	0.066[d]
Age (categorical)			0.046[a]*
18-24 years	18 (62.1)	11 (37.9)	
25-31 years	14 (35.0)	26 (65.0)	
32-39 years	11 (61.1)	7 (38.9)	
Age (continuous)			0.580[c]
Race[e]/ethnicity			
Hispanic	23 (43.4)	30 (56.6)	0.201[a]
Native Hawaiian or Other Pacific Islander	12 (80.0)	3 (20.0)	0.011[b]*
Asian	9 (60.0)	6 (40.0)	0.368[a]
American Indian or Alaska Native	1 (33.3)	2 (66.7)	1.0[b]
Black or African American	5 (45.5)	6 (54.6)	0.778[a]
White	18 (41.9)	25 (58.1)	0.163[a]
Education			0.870[a]
Less than college	18 (52.9)	16 (47.1)	
Some college	10 (47.6)	11 (52.4)	
College degree or higher	15 (46.9)	17 (53.1)	
Parity			0.547[b]
1	17 (50.0)	17 (50)	
2	19 (50.0)	19 (50.0)	
3	5 (38.5)	8 (61.5)	
4	2 (100.0)	0 (0)	
Use of prenatal vitamins			0.241[b]
No	2 (100.0)	0 (0)	
Yes	41 (48.2)	44 (51.8)	

Note: See footnote on next page

Table 4.3 continued. Results of bivariate analysis by breastfeeding status from a secondary data analysis of the association between pregravid BMI and breastfeeding discontinuation

Variable	Breastfeeding status at 4-6 months, n (%)		p-value
	Discontinued 43 (49.3)	Continued 44 (50.6)	
Pregnancy complications			0.761[a]
No	26 (48.2)	28 (51.9)	
Yes	17 (51.1)	16 (48.5)	
Took vitamins while breastfeeding			<0.0001[b]*
No	24 (64.9)	13 (35.1)	
Yes	12 (27.9)	31 (72.1)	
(No response given)	7 (100.0)	0 (0)	
Gestational age (weeks)			0.326[c]
Gestational weight gain (lb)			0.951[c]
Infant gender			0.163[a]
Male	25 (56.8)	19 (43.2)	
Female	18 (41.9)	25 (58.1)	
Up-to-date with vaccinations			0.747[a]
No	9 (52.9)	8 (47.1)	
Yes	34 (48.6)	36 (51.4)	

*p<0.05; [a]Analysis by Chi-square test; [b]Analysis by Fisher's exact test; [c]Analysis by t-test, Pooled; [d]Analysis by t-test, Satterthwaite; [e]Includes all races for mixed participants;
Note: Row percentages

Table 4.4. Association of pregravid body mass index (BMI) and covariates with breastfeeding discontinuation at 4-6 months postpartum

Variable	COR[a] (95% CI[b])	p-value	AOR[c] (95% CI)	p-value
Pregravid BMI (OWOB vs UN)	0.80 (0.34, 1.86)	0.5984	1.34 (0.44, 4.02)[d]	0.607
NHOPI vs all other race/ethnicity	-	-	7.12 (1.34, 37.97)[e]	0.022*
Age (years)				
18-24 vs 25-31	-	-	3.10 (0.91, 10.63)[f]	0.072
32-39 vs 18-24	-	-	1.36 (0.34, 5.47)[f]	0.668
32-39 vs 25-31	-	-	4.21 (1.13, 15.72)[f]	0.032*
Took vitamins while breastfeeding (Yes vs No)	-	-	0.15 (0.05, 0.46)[g]	0.0009*

OWOB, overweight or obese; UN, underweight or normal weight; *p<0.05; [a]COR: crude odds ratio, odds ratio test; [b]CI: confidence interval; [c]AOR: adjusted odds ratio, multivariable logistic regression; [d]Adjusted, controlling for NHOPI, age, took vitamins while breastfeeding; [e]Adjusted, controlling for age, pregravid BMI, took vitamins while breastfeeding; [f]Adjusted, controlling for pregravid BMI, NHOPI, took vitamins while breastfeeding; [g]Adjusted, controlling for pregravid BMI, NHOPI, age

CHAPTER 5. ASSOCIATIONS BETWEEN GESTATIONAL WEIGHT GAIN AND RATE OF INFANCY WEIGHT GAIN IN HAWAIʻI AND PUERTO RICO WIC PARTICIPANTS

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Abstract

Background: Excessive gestational weight gain and rapid infancy weight gain (RIWG) have been associated with increased susceptibility to childhood obesity and other adverse health conditions. Since low-income and minority children are particularly at risk for childhood obesity, investigation of the associations between gestational weight gain and rate of infancy weight gain may inform childhood obesity prevention in these groups.

Objective: This study investigated the associations between gestational weight gain and rate of infancy weight gain during the first four to six months postpartum in participants from the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) in Hawai‘i and Puerto Rico.

Design: This was a cross-sectional secondary data analysis from a text message-based intervention in WIC participants in Hawai‘i and Puerto Rico. The analysis included 80 mother/infant pairs from the control group who completed the follow-up visit when infants were four to six months old. Maternal weight, height, and gestational weight gain were self-reported. Infant weight was measured at the WIC clinics at baseline and follow-up. A proportional odds model was used to investigate the effect of gestational weight gain on infancy weight gain, adjusting for maternal age, pregravid BMI status, parity, and up-to-date with infant vaccinations.

Results: In comparison to recommended gestational weight gain, excessive and inadequate gestational weight gain was associated with 77% decreased (adjusted odds ratio [AOR]=0.23; 95% confidence interval [CI]=0.08, 0.70; p=0.01) and 71% decreased (AOR=0.29; 95% CI=0.09, 0.94; p=0.04) odds of RIWG versus on-track or slow infant weight gain, respectively. In comparison to women with one child, women with two children (AOR=0.31; 95% CI= 0.11, 0.87; p=0.026) or three or four children (AOR=0.24; 95% CI= 0.07, 0.88; p=0.031) had significantly lower odds of RIWG versus on-track or slow infancy weight gain.

Conclusions: Women with excessive or inadequate gestational weight gain had lower proportional odds of RIWG and were more likely to have slower infant weight gain than women who gained the recommended amount of weight. Achieving the recommended amount of gestational weight gain and keeping an infant’s weight gain on track are important to prevent malnutrition, failure to thrive, and undesirable metabolic programming that could lead to obesity and other adverse health conditions.

Introduction

Childhood overweight and obesity is a global public health concern and has increased from 32 to 41 million children from 1990 to 2016.[1] In the US, according to the 2011-2012 National Health and Nutrition Examination Survey (NHANES), 7.1% of infants and toddlers under the age of two years were at or above the 97.7th percentile, signifying high weight for length.[2] The 2011-2014 NHANES further indicated that 8.9% of US children aged two to five years and 17% of youth aged two through 19 years were obese.[3] Low-income and minority children are particularly at risk for obesity.[4] In 2014, 40% of US one-year-olds and 30% of two to five-year-olds participating in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), a federally funded program for low-income women and children,[5] were overweight or obese.[6,7] Among minority groups, Hispanic and Black children have increased odds of rapid infancy weight gain (RIWG),[8] and Native Hawaiian or Other Pacific Islander (NHOPI) children have higher body mass index (BMI) between two and four months of age compared to other races.[9]

Although infants display the greatest variation in rates of weight gain during the first and second years after birth,[10] the first six months are a critical time of rapid growth during which metabolic programming can occur, leading to increased susceptibility to obesity later in life.[11–13] Rapid weight gain during the first two years is associated with higher BMI, greater percentage of body fat, and more total fat mass,[10] as well as other problems later in life, such as overweight, obesity, high blood pressure, and diabetes.[14–17] Children who displayed catch-up growth, a compensatory mechanism for intrauterine growth restraint[10,18] or low birth weight,[19] during the first two years were heavier, taller, and had more central fat than other children.[10] Similarly, children displaying rapid infancy weight gain (defined as >+0.67 change in weight-for-age z-scores) in the first two years had about 7 kg more total body fat and 3 kg greater abdominal adipose tissue at age 30-61 years (mean age 46.5 years).[20] In Hawai‘i, it was shown that a greater change in weight between two and 24 months was associated with higher BMI at age five[9] and that rapid growth from 12 to 23 months was associated with obesity at four to five years in low-income Filipino and NHOPI children.[21]

Similarly, maternal weight gain during pregnancy may have significant effects on weight of offspring.[22] Genetic, dietary, or other behavioral factors that increase gestational weight gain

may program offspring weight gain by altering the fetal intrauterine environment.[22] Excessive gestational weight gain is associated with increased neonatal fat mass and body fat percentage, possibly indicating that neonatal adiposity is influenced by maternal fat accumulation and the intrauterine environment during early and mid-pregnancy.[23] One study reported mothers with greater weight gain during pregnancy had children with greater adiposity at age three as measured by BMI and skinfold thickness.[22] Other studies have concluded that excessive gestational weight gain is associated with abnormal weight in offspring, with higher risk of high BMI at ages two and eight,[24] obesity at age eight,[25] and increased risk of obesity in adolescence and early adulthood.[26] In the Northwest and Hawai‘i, excessive gestational weight gain was shown to increase the risk of childhood obesity independently of maternal hyperglycemia.[27]

Therefore, excessive maternal gestational weight gain and RIWG are two important factors associated with childhood overweight and obesity. Preventing excessive gestational weight gain, a modifiable maternal risk factor, may allow for prevention of RIWG. Examination of this association may be informative for obesity prevention strategies. The association between these factors has not been examined extensively, but a positive association or trend has been reported in other studies.[28–32] However, no studies have been conducted in Hawai‘i or Puerto Rico, and to our knowledge, this is the first study to assess the association in low-income women in these locations. We hypothesized that excessive gestational weight gain is positively associated with RIWG in the first four to six months postpartum in this population.

Methods

Participants

We conducted a cross-sectional secondary data analysis using data collected from a four-month text message-based intervention aimed at preventing excessive weight gain in infants at Hawai‘i and Puerto Rico WIC clinics.[33] Eligibility criteria for mothers/caregivers included the following: at least 18 years old, owned a mobile phone with unrestricted texting capabilities, were responsible for caring for the infant, and were willing to complete the entire study. Additionally, inclusion criteria required the infant to have been no more than two months old at baseline, to have been born after 37 weeks of gestation, to be on a normal diet and free from disabilities that hinder movement, and to have had birthweight at or between the 10th and 90th

percentiles as indicated by the World Health Organization (WHO) growth charts.[34] A convenience sample of infants (n = 202) and their mother/caregiver were recruited from four WIC clinics in Hawai‘i and two WIC clinics in Puerto Rico from January to April, 2016. Participants were assigned to control or intervention groups by block randomization. Detailed methods used in the trial have been published elsewhere.[33] Study procedures were approved by the institutional review boards at the University of Hawai‘i at Mānoa and the University of Puerto Rico, Medical Sciences Campus, and informed consent was obtained prior to data collection.

Measures

The baseline assessment included questionnaires and infant anthropometric measurements. Data collected from the questionnaires included the following: socio-demographic information such as race, mother's age, and infant's gender; pregnancy- and health-related information such as maternal pregravid weight and height, weeks of gestation at delivery, weight gained during pregnancy, and infant vaccinations; food frequency information; and infant feeding practices information such as breastfeeding initiation and duration, reasons for discontinuing breastfeeding, and complementary foods used. Questionnaires and anthropometric measurements were repeated at the follow-up visit four months after the completion of the baseline assessment.

Analyses for the current study included the control group only (n=100). At baseline, gestational weight gain (exposure) was assessed by self-report on the general demographics questionnaire using item, "How much weight did you gain during pregnancy?" Pregravid BMI was calculated using self-reported weight and height. Pregravid BMI was defined based on the National Institutes of Health classifications for BMI (kg/m^2): underweight (<18.5), normal (18.5–24.9), overweight (25–29.9), obese (≥30).[35] Based on these BMI ranges, excessive gestational weight gain was defined as weight gain above the 2009 Institute of Medicine (IOM) gestational weight gain guidelines: underweight women are recommended to gain 28-40 lb; normal weight women are recommended to gain 25-35 lb; overweight women are recommended to gain 15-25 lb; obese women are recommended to gain 11-20 lb.[36]

Infant weight and length were measured in duplicate by trained researchers and WIC employees at baseline and follow-up using Doran infant pan scales (model DS4100) and Easy Glide Bearing Infantometers (Perspective Enterprises, PE-RILB-BRG2) provided by the WIC clinics. Weight was measured with light or no clothes, no shoes, and a clean diaper. Infant age at follow-up ranged from four to six months. As the preferred system for analysis of anthropometric data,[37] z-scores were used for assessment. Z-scores are independent of sex and age, and different age and sex groups may be combined for growth evaluation.[38] Infancy weight gain (main outcome of interest) z-scores are defined as the change in weight-for-age z-scores from baseline to follow-up, calculated using the WHO AnthroPlus online calculator,[39] which is based upon WHO reference values.[40,41] Rapid infancy weight gain is defined as a change in weight gain z-score of +0.67 to +1.28, representing upwards crossing of at least one percentile line on WHO standard growth charts; extremely rapid weight gain is >+1.28, representing upwards crossing of two or more percentile lines on WHO standard growth charts.[10,42–45] Similarly, change in weight-for-age z-score between -0.67 and 0.67 is defined as on-track infancy weight gain in which there is no crossing of percentile lines, and slow infancy weight gain occurs when weight gain z-score <-0.67, representing downward crossing of one or more percentile lines.[42]

Figure 5.1 describes inclusion in the analysis group. Eighty-two participants from the control group who completed the follow-up visit and had complete data were included in the final analysis group. Eighteen participants were lost to follow up: Hawai‘i (n=13) and Puerto Rico (n=5).

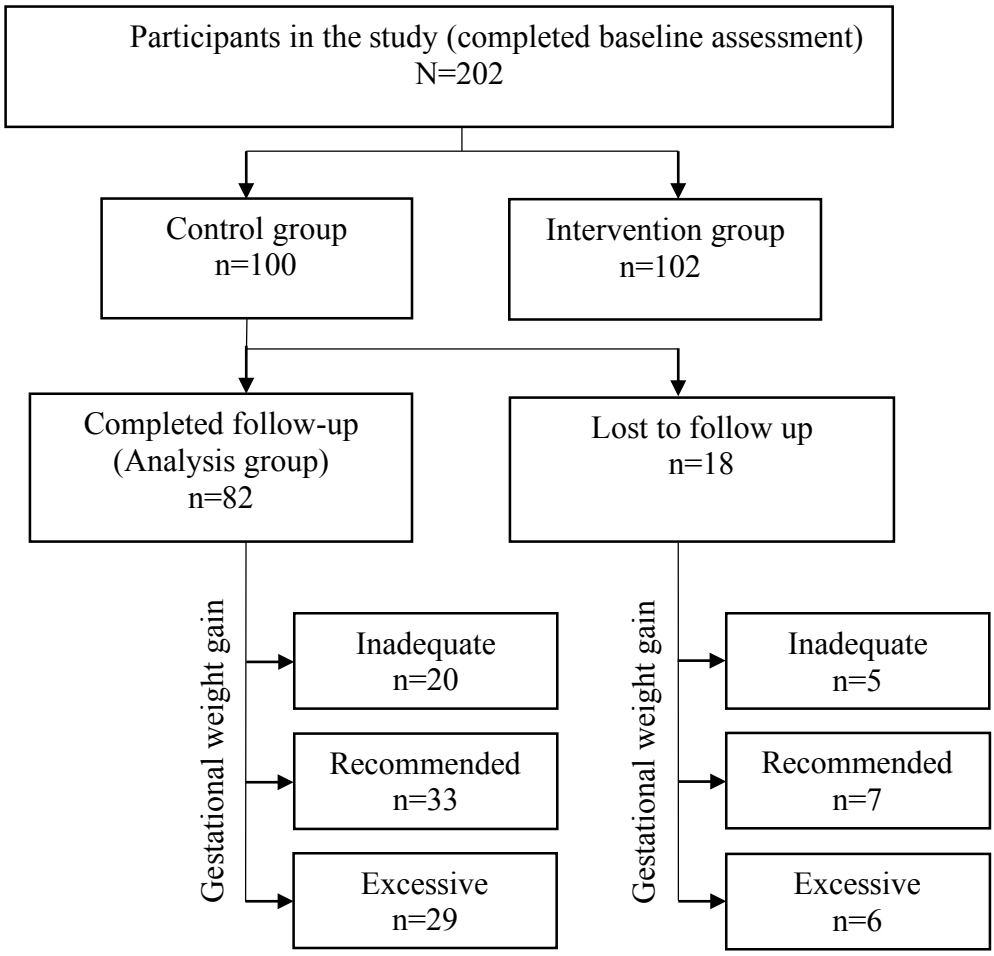

Figure 5.1. Final analysis group and participants lost to follow-up for a secondary data analysis of gestational weight gain and rate of infancy weight gain

Variables

Dependent variable

Rate of infancy weight gain during the first four to six months postpartum was defined as a ternary outcome in mothers from the control group (n=100) who completed the study (n=82). Rapid and extremely rapid weight gain were combined into one category, simply referred to as rapid infancy weight gain (RIWG).

Independent variable

Maternal gestational weight gain was categorized as "recommended," "inadequate," or "excessive."

Possible covariates

Variables tested as possible covariates included site (Hawai'i or Puerto Rico), mother's race/ethnicity, mother's age (divided into three strata by years: 18-24, 25-31, and 32-39), mother's education level, parity, use of prenatal vitamins during pregnancy, pregnancy complications (such as diabetes, hypertension, or anemia), use of vitamins while breastfeeding, weeks of gestation at delivery, pregravid BMI status, infant gender, and being up-to-date with infant vaccinations. Based upon the US Office of Management and Budget standards,[46] race/ethnicity was categorized into the following groups: Hispanic, NHOPI, American Indian or Alaska Native, Asian, Black or African American, and White.

Statistical analyses

For baseline characteristics, descriptive statistics were presented using frequencies and percentages, or using means and standard deviations. Chi-squares tests, Fisher's exact tests, and analysis of variance (ANOVA) were conducted to investigate the bivariate associations between baseline characteristics and rate of infancy weight gain. Fisher's exact test was used to examine the bivariate association between rate of infancy weight gain (rapid or extremely rapid, on-track, or slow) and gestational weight gain (recommended, inadequate, or excessive).

To determine the effect of gestational weight gain on RIWG, an adjusted proportional odds regression was conducted. Also known as cumulative logit model or ordered logistic

regression, proportional odds regression uses cumulative probabilities for models with three or more ordinal response variables. The proportional odds model is represented by the equation:

$$logit[P(Y \leq j)]=\alpha_j+\beta*x, j=1, \ldots, J\text{-}1$$

and compares the probability of a response variable less than or equal to a given level to the probability of a response greater than this level.[47,48] In this equation, j is the level of an ordered response variable and J is the total number of levels. The intercept, α, changes with j, and β is the slope.

The covariates in the final proportional odds model were pregravid BMI status (combined as underweight/normal (UN) or overweight/obese (OWOB)), being up-to-date with infant vaccinations, parity, and maternal age. For the final model, a chi-square score test for the proportional odds assumption was used to determine goodness of fit. From the bivariate analyses, demographic variables with a p value of <0.15 were included in the final model.[49,50] For all other analyses, a p-value of <0.05 was considered statistically significant. Analyses were performed using SAS 9.4 and SAS University Edition (Cary, NC).

Results

Thirty-seven participants (45.1%) from Hawai‘i and 45 participants (54.9%) from Puerto Rico were included in the final analysis (n=82). Characteristics of the control group, final analysis group, and group that was lost to follow-up are shown in Table 5.1. Comparing participants in the final analysis group (n=82) with those who did not complete the study (n=18), no statistically significant differences were found for pregravid BMI, race/ethnicity, parity, pregnancy complications, infant gender, being up-to-date with vaccines, taking vitamins while breastfeeding, maternal age, gestational age at birth, or gestational weight gain. Women who were in Hawai‘i (p=0.04), who did not take prenatal vitamins during pregnancy (p=0.03), or who had less than a college education (p=0.02) were more likely to have been lost to follow-up.

Forty-four women (53.7%) were underweight or normal weight prior to pregnancy, and 38 women (46.3%) had overweight or obese pregravid BMI. The majority of women were Hispanic (62.2%) and among all races, White was the most prevalent (48.8%). Fifteen percent of mothers were NHOPI. All of the women used prenatal vitamins and most (79.3%) were up-to-date with infant vaccinations.

Mean gestational weight gain was 27.7 lb (SD=12.1). Thirty-three women (40.2%) gained the recommended amount of weight during pregnancy, 20 women (24.4%) gained inadequate amounts, and 29 (35.4%) women had excessive gestational weight gain. During the first four to six months postpartum, 19 infants (23.2%) experienced RIWG, 42 infants (51.2%) experienced on-track weight gain, and 21 infants (25.6%) had slow weight gain. As shown in Table 5.2, almost half (48.5%) of women who gained the recommended amount of weight during pregnancy had infants who displayed on-track weight gain that did not cross over percentile lines on the WHO growth charts (change in weight-for-age z-score between -0.67 and 0.67). More than half (58.6%) of women with excessive gestational weight gain had infants who displayed on-track weight gain. Of mothers who gained excessive weight during pregnancy, more infants displayed slow infancy weight gain (31.0%) than RIWG (10.3%). The majority of infants who displayed RIWG (63.2%) came from mothers who gained the recommended amount of weight during pregnancy. At baseline, all except one infant's weight-for-age z-score fell within -2 to +2 on the WHO growth chart, which is the range considered "normal" based upon the statistical definition of the central 95% on a normal curve.[38]

Table 5.2 presents the results for the bivariate analysis, which showed the association between rate of infancy weight gain and the following variables were not statistically significant: site, race/ethnicity, pregnancy complications, took vitamins while breastfeeding, education, gestational age at birth, and infant gender. Variables with $p<0.15$ were included in the final adjusted proportional odds cumulative logit model: pregravid BMI ($p=0.067$), parity ($p=0.142$), maternal age ($p=0.047$), and up-to-date with infant vaccinations ($p=0.061$).

In the unadjusted bivariate analysis, Fisher's exact test showed the association between gestational weight gain and the rate of infancy weight gain was not statistically significant ($p=0.108$). However, in the adjusted model (Table 5.3), the association between gestational weight gain and RIWG was statistically significant. In comparison to recommended gestational weight gain, excessive gestational weight gain was associated with 77% decreased odds of RIWG versus on-track or slow infant weight gain (adjusted odds ratio (AOR)=0.23; 95% CI=0.08, 0.70; $p=0.01$). That is, women with excessive gestational weight gain were more likely (4.3 times the odds) to have slower infant weight gain than women who gained the recommended amount of gestational weight.

In comparison to recommended gestational weight gain, inadequate gestational weight gain (under the recommended amount) was associated with 71% decreased odds of RIWG versus on-track or slow infant weight gain (AOR=0.29; 95% CI=0.09, 0.94; p=0.04). In other words, women with inadequate gestational weight gain were more likely (3.5 times the odds) to have slower infant weight gain than women who gained the recommended amount of gestational weight.

The adjusted model (Table 5.3) also indicated that, in comparison to women with one child, women with two children (AOR=0.31; 95% CI= 0.11, 0.87; p=0.026) or three or four children (AOR=0.24; 95% CI= 0.07, 0.88; p=0.031) had significantly lower odds of RIWG versus on-track or slow infancy weight gain. Although not statistically significant, women who were up-to-date with infant vaccinations had 68% decreased odds of RIWG versus on-track or slow infancy weight gain (AOR=0.32; 95% CI= 0.10, 1.03; p=0.056).

The goodness-of-fit test for the proportional odds assumption was used to validate our model; the p-value was 0.64, indicating good fit.

Discussion

In contrast to our hypothesis, excessive gestational weight gain was associated with decreased, not increased, odds of RIWG. The majority of infants with RIWG (63.2%) were from mothers who achieved recommended gestational weight gain. Therefore, preventing excessive gestational weight gain may not affect the odds of RIWG. The latter would need to be addressed separately in prevention programs. This finding was in contrast to the results from a number of studies in diverse populations that revealed a positive association between the two.[28–32] For example, a study in China reported excessive gestational weight gain was associated with RIWG across all BMI categories.[28] The difference in results between the studies could have resulted from differences related to nationality and/or race, such as diet, environment, or physical stature. For example, Asian adults have higher percentage of body fat than whites of the same BMI, age, and sex.[51] In the current study, almost half of the participants were white and only 17% were Asian, whereas 100% of the population were Chinese in the aforementioned study. More research is needed to understand the factors and mechanisms behind these differences.

In comparison to recommended gestational weight gain, both excessive gestational weight gain and inadequate gestational weight gain, separately, were associated with higher odds of slow infancy weight gain versus RIWG or on-track infancy weight gain. Another study of normal birthweight infants reported that slow infancy weight gain between ages eight weeks and nine months was followed by RIWG; however, children did not return to mean reference weights until age 13 years and they remained lighter and shorter than their peers throughout childhood.[52] Infants from the same cohort who were born smaller or thinner, yet still within normal ranges, and then experienced RIWG, were reported to have increased risk for central and peripheral obesity in childhood and potential risk for disease as adults.[10] Since inadequate gestational weight gain may lead to intrauterine growth restraint, resulting in infants being smaller at birth,[53,54] it may be worthwhile in future studies to consider birth anthropometrics in data analysis. Moreover, since the current study followed infant weight gain only up until six months of age, future studies should observe rates of weight gain beyond this period to see if similar patterns hold true in this population.

The current study found that 25.6% of infants experienced slow infancy weight gain. Nine infants with slow infancy weight gain (including four infants from mothers with excessive gestational weight gain and three infants from mothers with inadequate gestational weight gain) fell into the category of "failure to thrive" (FTT), defined as a child under two years whose weight crosses two major percentiles downward on a standardized growth chart.[55] Like RIWG, slow infancy weight gain may be associated with adverse health conditions and must be addressed to prevent unfavorable outcomes later in life. Slow infancy weight gain, especially when severe enough to be considered FTT, may be a sign of feeding problems, malnutrition, or of other physiological conditions that lead to inadequate calorie intake, inadequate calorie absorption, or increased calorie requirements.[55] Failure to thrive is associated with decreased developmental skills, lower height and weight, lower verbal intelligence, lower social maturity, and increased behavioral disturbances.[55,56] Therefore, excessive or inadequate gestational weight gain may be an important risk factor for developing adverse health conditions related to FTT, and are important to address in pregnant women.

In comparison to first-time mothers with only one child, multiparous women with two to four children had approximately 3-4 times the odds of slow infancy weight gain versus RIWG or

on-track infancy weight gain. First-time mothers had higher odds of rapid infancy weight gain. Likewise, a study conducted in the United Kingdom reported infants of first-time mothers displayed RIWG during the first year and, thereafter, were heavier and taller than infants from multiparous mothers.[57] A similar finding was reported in primiparous mothers in Denmark whose infants gained more weight during the first year than infants of multiparous women.[58] Different parenting behaviors between first-time mothers and multiparous mothers may influence infant nutrition.[57] A study in Australia reported that first-time mothers failed to demonstrate an understanding of the rationale supporting the WHO guidelines to exclusively breastfeed for the first six months, nor did they comprehend well the signs of readiness for solid foods.[59] Formula feeding and feeding-to-schedule may lead to overfeeding and are associated with RIWG.[60] Likewise, early introduction of solid foods along with shorter duration of breastfeeding may partially explain greater infant weight gain.[58] Therefore, women may benefit from nutrition and infant care education during their first pregnancies to prevent RIWG and during subsequent pregnancies to prevent slow infancy weight gain and FTT.

Many studies have shown that excessive gestational weight gain is associated with increased risk for obesity.[24–27] This association has public health implications, as excessive gestational weight gain is not uncommon in the US. In 2015, 48% of uniparous women who gave birth to a full-term infant in the US had excessive gestational weight gain.[61] The current study found that more than one-third (35.4%) of the women in the final analysis gained excessive gestational weight, making it an important risk factor to address in this population.

Along with epidemiological evidence, the physiological mechanisms driving excessive gestational weight gain to metabolically program offspring weight gain towards overweight or obesity[27] are important to consider in obesity prevention strategies. Potential mechanisms involved in metabolic imprinting through excessive gestational weight gain include the following: 1) higher levels of maternal circulating insulin during the third trimester[62] leads to increased levels of adipocyte development and fat storage in the fetus, 2) excessive maternal adipose tissue accumulation increases low-grade chronic inflammation and circulating adipokines, possibly creating an inflammatory environment for the fetus and promoting excess body fat accumulation,[63] 3) fetal metabolic programming is influenced by epigenetic changes brought on by maternal diet.[64,65] Based upon these mechanisms, one prevention strategy may

involve providing at-risk women with vigorous nutrition/diet counseling and accountability along with frequent blood glucose monitoring, if applicable.

It is possible that other factors that were not considered in the current analysis mediated the association between excessive gestational weight gain and RIWG. It was recently reported that, as mediators, breastfeeding duration and birth weight accounted for up to 76% of the total effect of gestational weight gain on weight-for-age z-scores.[66] The current study investigated the change in weight-for-age z-scores as indicative of infant weight gain, rather than single point measurements, but it is notable that these variables could have mediated the current observations. It is also possible that the associations observed in the current study may have changed had it been conducted over a longer period. In the aforementioned study, it was reported that the direct effects of gestational weight gain on weight-for-age z-scores and BMI z-scores were not significant until children were six years old.[66] Therefore, since birth weight and breastfeeding duration may be important mediators between gestational weight gain and anthropometric measures during infancy and early childhood,[66] it would be prudent to include these variables in future analyses and studies.

Although mainly a measure of energy balance, weight-for-age has been used most often as the metric in studies on infancy growth and later obesity.[67] However, a study that examined the differences in association between adult overweight/obesity and infant weight-for-age versus weight-for-length measurements suggested that weight-for-length during the first two years is a more comprehensive metric for infant growth and provides a stronger, more consistent association with overweight/obesity in young adulthood.[68] However, using weight-for-length versus weight-for-age measurements, the study reported similar odds ratios (OR) for being overweight at age 20-29 years based on rapid growth ($\geq$+0.67 z-score) compared to non-rapid growth from birth to six months (OR 1.67 vs. 1.69) and from birth to three months (OR 1.13 vs. 1.07).[68] Therefore, since the current study only examined infants up to six months of age, and considering the preponderance of previous studies using weight-for-age, weight-for-age was chosen as the metric. However, future studies that look at growth beyond six months may benefit from using weight-for-length measurements.

Weight gain during infancy plays an important role in overall growth and disease risk throughout life.[10,52] Considering the results presented, weight gain in excess of or below the

recommended amounts set forth by the 2009 IOM guidelines may lead to adverse health outcomes related to slow infancy weight gain and subsequent growth patterns. Preventing excessive or inadequate gestational weight gain may work simultaneously to prevent slow infancy weight gain in this population of low-income WIC participants. This finding may be helpful in informing health promotion and obesity prevention strategies and programs for women in WIC in Hawai‘i and Puerto Rico.

Limitations of the study

Our study has several limitations. First, the sample size was small. However, the majority of participants in the final analysis group was Hispanic, making 77% of the final analysis group Hispanic or NHOPI. Larger studies, especially with a greater percentage of NHOPI participants, should be conducted to further investigate the associations described in this study. Second, our results are not generalizable to women beyond those participating in the study due to the inherent bias of convenience sampling. However, this study provides new information that may inform future studies. Third, maternal height, pregravid weight, and gestational weight gain were self-reported. Fourth, although the infant pan scales at WIC are calibrated once a year, they were not calibrated immediately prior to our study and it is possible that measurements could have incurred some systematic error. Finally, although researchers were trained in proper techniques and documentation of measurements, having multiple researchers taking anthropometric measurements may have introduced human error. Additionally, 11 participants from Hawai‘i (29.7%) had infant anthropometric measurements taken in-part or in-full by WIC staff, whose training differed from the research team. All measurements in Puerto Rico were taken by the research team.

Conclusion

In low-income WIC participants in Hawai‘i and Puerto Rico, excessive gestational weight gain did not increase susceptibility to RIWG; however, both variables are risk factors for childhood obesity and collectively affected more than half of the women/infants in this sample. Preventing excessive and inadequate gestational weight gain may benefit infant health by preventing slow infancy weight gain and FTT. Achieving the recommended amount of

gestational weight gain and keeping an infant's weight gain on track are important to prevent malnutrition and undesirable metabolic programming. The results of this study may inform obesity prevention strategies.

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Table 5.1. Distribution of select maternal and infant characteristics, n (%), for the control, final analysis, and lost to follow-up groups from a secondary data analysis of gestational weight gain (GWG) and rate of infancy weight gain

	Total control (n=100)	Final analysis (n=82)	Lost to follow-up (n=18)	p-value
Site				0.037[a]*
Hawai‘i	50 (50.0)	37 (45.1)	13 (72.2)	
Puerto Rico	50 (50.0)	45 (54.9)	5 (27.8)	
Maternal factors				
Pregravid BMI (mean [SD])	26.1 [6.9]	26.3 [7.0]	24.8 [6.6]	0.340[b]
Underweight or normal	56 (56.0)	44 (53.7)	12 (66.7)	
Overweight or obese	44 (44.0)	38 (46.3)	6 (33.3)	
Age (mean [SD])	27.0 [5.0]	26.9 [4.7]	27.4 [6.5]	0.958[a]
18-24 years	33 (33.0)	27 (32.9)	6 (33.3)	
25-31 years	47 (47.0)	39 (47.6)	8 (44.4)	
32-39 years	20 (20.0)	16 (19.5)	4 (22.2)	
Race[c]/ethnicity				
Hispanic	60 (60.0)	51 (62.2)	9 (56.3)	0.655[a]
Native Hawaiian or Other Pacific Islander	17 (17.0)	12 (14.6)	5 (27.8)	0.179[a]
Asian	20 (20.0)	14 (17.1)	6 (33.3)	0.118[a]
American Indian or Alaska Native	4 (4.0)	3 (3.7)	1 (5.6)	0.555[b]
Black or African American	12 (12.0)	11 (13.4)	1 (5.6)	0.689[b]
White	45 (45.0)	40 (48.8)	5 (27.8)	0.105[a]
Education				0.019[b]*
Less than college	42 (42.0)	31 (37.8)	11 (61.1)	
Some college	22 (22.0)	22 (26.8)	0 (0)	
College degree or higher	36 (36.0)	29 (35.4)	7 (38.9)	
Parity				0.112[b]
1	38 (38.0)	32 (39.0)	6 (33.3)	
2	43 (43.0)	34 (41.5)	9 (50.0)	
3 or 4	19 (19.0)	16 (19.5)	3 (16.7)	
Use of prenatal vitamins	98 (98.0)	82 (100.0)	16 (88.9)	0.031[b]*
Pregnancy complications	41 (41.0)	31 (37.8)	10 (55.6)	0.166[a]
Took vitamins while breastfeeding	53 (53.0)	42 (51.2)	11 (68.8)	0.319[a]
Gestational age (weeks; mean [SD])	38.9 [1.0]	38.9 [1.0]	38.9 [1.1]	0.844[d]
GWG (lb; mean [SD])	27.9 [12.2]	27.7 [12.1]	28.7 [12.9]	0.759[d]
Infant factors				
Male	52 (52.0)	40 (48.8)	12 (66.7)	0.169[a]
Female	48 (48.0)	42 (51.2)	6 (33.3)	
Up-to-date with vaccinations	81 (81.0)	65 (79.3)	16 (88.9)	0.512[b]

Note: Column percentages; p-value represents final analysis vs lost to follow-up; *p<0.05; [a]Analysis by Chi-square test; [b]Analysis by Fisher's exact test; [c]Includes all races for mixed participants; [d]Analysis by t-test, pooled

Table 5.2. Results of bivariate analysis by rate of infancy weight gain from a secondary data analysis of the association between gestational weight gain and rate of infancy weight gain

Variable	Rate of infancy weight gain, n (%)			p-value
	Rapid or extremely rapid 19 (23.2)	On-track 42 (51.2)	Slow 21 (25.6)	
Site				0.615[a]
Hawai‘i	7 (18.9)	21 (56.8)	9 (24.3)	
Puerto Rico	12 (26.7)	21 (46.7)	12 (26.7)	
Gestational weight gain				0.108[b]*
Recommended	12 (36.4)	16 (48.5)	5 (15.2)	
Inadequate	4 (20.0)	9 (45.0)	7 (35.0)	
Excessive	3 (10.3)	17 (58.6)	9 (31.0)	
Pregravid BMI				0.067[b]*
Underweight	2 (28.6)	2 (28.6)	3 (42.9)	
Normal	8 (21.6)	21 (56.8)	8 (21.6)	
Overweight	6 (31.6)	12 (63.2)	1 (5.3)	
Obese	3 (15.8)	7 (36.8)	9 (47.4)	
Race[d]/ethnicity				0.870[b]
Hispanic	12 (23.5)	26 (51.0)	13 (25.5)	
Native Hawaiian	2 (28.6)	2 (28.6)	3 (42.9)	
Other Pacific Islander	3 (50.0)	3 (50.0)	0 (0)	
Native Hawaiian or Other Pacific Islander	4 (33.3)	5 (41.7)	3 (25.0)	
Asian	2 (14.3)	8 (57.1)	4 (28.6)	
American Indian or Alaska Native	1 (33.3)	1 (33.3)	1 (33.3)	
Black or African American	1 (9.1)	7 (63.6)	3 (27.3)	
White	11 (27.5)	20 (50.0)	9 (22.5)	
Parity				0.142[b]*
1	12 (37.5)	15 (46.9)	5 (15.6)	
2	5 (14.7)	19 (55.9)	10 (29.4)	
3 or 4	2 (12.5)	8 (50.0)	6 (37.5)	
Use of prenatal vitamins				
Yes	19 (23.2)	42 (51.2)	21 (25.6)	
Pregnancy complications				0.693[a]
No	11 (21.6)	28 (54.9)	12 (23.5)	
Yes	8 (25.8)	14 (45.2)	9 (29.0)	
Took vitamins while breastfeeding				0.921[b]
No	7 (20.6)	17 (50.0)	10 (29.4)	
Yes	11 (26.2)	21 (50.0)	10 (23.8)	
(No response given)	1 (16.7)	4 (66.7)	1 (16.7)	

Note: Row percentages; See footnote on next page

Table 5.2 continued. Results of bivariate analysis by rate of infancy weight gain from a secondary data analysis of the association between gestational weight gain and rate of infancy weight gain

Variable	Rate of infancy weight gain, n (%)			p-value
	Rapid or extremely rapid 19 (23.2)	On-track 42 (51.2)	Slow 21 (25.6)	
Education				0.274[b]
Less than college	9 (29.0)	11 (35.5)	11 (35.5)	
Some college	4 (18.2)	13 (59.1)	5 (22.7)	
College degree or higher	6 (20.7)	18 (62.1)	5 (17.2)	
Gestational age (weeks)				0.564[c]
Maternal age (years)				0.047[b]*
18-24	11 (40.7)	11 (40.7)	5 (18.5)	
25-31	5 (12.8)	20 (51.3)	14 (35.9)	
32-39	3 (18.8)	11 (68.8)	2 (12.5)	
Infant gender				0.257[a]
Male	10 (25.0)	23 (57.5)	7 (17.5)	
Female	9 (21.4)	19 (45.2)	14 (33.3)	
Up-to-date with vaccinations				0.061[b]*
No	6 (35.3)	10 (58.8)	1 (5.9)	
Yes	13 (20.0)	32 (49.2)	20 (30.8)	

Note: Row percentages;
*$p<0.15$; [a]Analysis by Chi-square test; [b]Analysis by Fisher's exact test; [c]Analysis by ANOVA; [d]Includes all races for mixed participants

Table 5.3. Proportional odds model and adjusted odds ratios using rate of infancy weight gain as the dependent variable for a secondary data analysis of the association between gestational weight gain and rate of infancy weight gain

Independent variable	Estimate[a] (SE)[b]	p-value	AOR[c] (95% CI[d])	
			Rapid vs on-track or slow	Slow vs rapid or on-track
Intercept				
Rapid vs on-track or slow	1.16 (0.69)	0.093		
Rapid or on-track vs slow	4.00 (0.83)	<0.0001*		
Gestational weight gain[e]				
Recommended	Reference			
Excessive	-1.46 (0.57)	0.010*	0.23 (0.08, 0.70)	4.32 (1.42, 13.14)
Inadequate	-1.24 (0.60)	0.039*	0.29 (0.09, 0.94)	3.45 (1.07, 11.17)
Maternal age (years)[f]				
18-24	Reference			
25-31	-0.60 (0.57)	0.289	0.55 (0.18, 1.67)	1.83 (0.60, 5.54)
32-39	0.02 (0.67)	0.975	1.02 (0.28, 3.77)	0.98 (0.27, 3.61)
Pregravid BMI[g]				
Underweight/normal	Reference			
Overweight/obese	0.30 (0.50)	0.555	1.35 (0.50, 3.61)	0.73 (0.28, 1.99)
Parity[h]				
1 child	Reference			
2 children	-1.16 (0.52)	0.026*	0.31 (0.11, 0.87)	3.20 (1.15, 8.93)
3 or 4 children	-1.43 (0.66)	0.031*	0.24 (0.07, 0.88)	4.17 (1.14, 15.28)
Up-to-date with infant vaccinations[i]				
No	Reference			
Yes	-1.15 (0.60)	0.056	0.32 (0.10, 1.03)	3.15 (0.97, 10.21)

*p<0.05; [a]Ordered log-odds regression coefficient; [b]SE: Standard error of the estimate; [c]AOR: adjusted odds ratio; [d]CI: confidence interval; [e]Controlled for maternal age, pregravid BMI, parity, up-to-date with infant vaccinations; [f]Controlled for gestational weight gain, pregravid BMI, parity, up-to-date with infant vaccinations; [g]Controlled for gestational weight gain, maternal age, parity, up-to-date with infant vaccinations; [h]Controlled for gestational weight gain, maternal age, pregravid BMI, up-to-date with infant vaccinations; [i]Controlled for gestational weight gain, maternal age, pregravid BMI, parity

CHAPTER 6. CONCLUSION

Childhood obesity is a significant public health problem around the world,[1] and low-income and minority children are especially at risk.[2] Non-traditional prevention methods, such as those using text messaging and other mobile health (mHealth) strategies, may be more effective in some populations.[3] Assessing acceptability of mHealth interventions is necessary to determine their effectiveness,[4] but this has not been evaluated in many infant health studies. It is important to assess acceptability of text message-based interventions for childhood obesity prevention to improve program designs and effectiveness. It is also important to examine the associations between maternal and infant factors related to childhood overweight and obesity. For example, high pregravid body mass index (BMI), rapid infancy weight gain, and excessive gestational weight gain are risk factors associated with childhood overweight and obesity,[5–7] whereas breastfeeding is protective against obesity later in life,[8] and the associations between these factors may inform the development of childhood obesity prevention programs and strategies.

The objectives of this dissertation were to 1) determine the acceptability of a text message-based intervention aimed at promoting breastfeeding and preventing excessive weight gain; 2) examine the association between maternal pregravid BMI and breastfeeding discontinuation; and 3) investigate the association between gestational weight gain and rate of infancy weight gain in infants from the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) in Hawai‘i and Puerto Rico.

Research Summary

Three research studies were conducted to meet the objectives of this dissertation. The first study (Chapter 3), “Acceptability of a text message-based intervention for obesity prevention in infants from Hawai‘i and Puerto Rico WIC,” assessed acceptability in 92 participants using qualitative and quantitative methods. The intervention was found to be acceptable to participants based upon participant retention, measures of satisfaction, and reports of behavior change. The results may inform mobile health programs for childhood obesity prevention and breastfeeding promotion.

The second study (Chapter 4), “Association between maternal pregravid body mass index and breastfeeding discontinuation in Hawai‘i and Puerto Rico WIC participants,” found that the

association between breastfeeding discontinuation and pregravid BMI was not significant in the sample of 87 participants. However, Native Hawaiian or Other Pacific Islanders (NHOPIs) and older women (aged 32-39 years vs 25-31 years) showed significantly higher odds of discontinuing breastfeeding, while women who took vitamins while breastfeeding had lower odds of discontinuing breastfeeding. The results may inform infant health programs but should be further investigated with larger samples.

Findings from the sample of 82 participants in the third study (Chapter 5), "Associations between gestational weight gain and rate of infancy weight gain in Hawai'i and Puerto Rico WIC participants," included decreased proportional odds of rapid infancy weight gain with excessive and inadequate gestational weight gain in comparison to recommended gestational weight gain. Women with excessive or inadequate gestational weight gain and multiparous women were more likely to have slower infant weight gain. Therefore, achieving the recommended amount of gestational weight gain and keeping an infant's weight gain on track are important to prevent malnutrition and other conditions that could lead to obesity and adverse health.

Additional Aspects of the Intervention and Future Considerations

English and Spanish translations

There are several issues that arise when translating instruments from one language and culture to another. For example, reliability, validity, and usefulness across populations should be checked to ensure that translated instruments measure the same constructs as the original and that results from the translated instrument are comparable to results from the original.[9] A translated instrument should perform like the original, and a successful translation should focus on cross-cultural and conceptual comparability, rather than on linguistic or literal equivalence.[9,10]

The WHO guidelines for translation and adaptation of instruments includes the following steps: 1) forward translation; 2) expert panel review; 3) back-translation; 4) pre-testing and cognitive interviewing; 5) final version and documentation.[10] For forward translation, the translator's native language should be the same as the target language, and the translator should be familiar with subject terminology.[10] Translations should be conceptually equivalent to the English original, written concisely and simply, avoiding jargon.[10] The expert panel should be bilingual in English and the target language and should generally include the original translator,

experts in the field, and experts in instrument development and translation.[10] The job of the expert panel is to review the translation to identify inadequate concepts and to suggest alternative words or phrases, if appropriate.[10] Back translation should be completed by a separate translator whose native language is English and should be limited to selected items that are key to the instrument or sensitive to translation problems.[10] After back translation has been completed, the translated instrument should be tested in the target population and participants should be interviewed afterwards to determine if changes need to be made to the instrument.[10] Finally, the final version should be accompanied by documentation of the initial forward translation, a summary of recommendations by the expert panel, the back translation, and a summary of problems and modifications arising from pre-testing.[10]

For the text message-based intervention in this dissertation, text messages were written in English by the principal investigators. Forward translation was completed in Spanish by a bilingual college student in Puerto Rico whose native language was Spanish. The expert panel consisted of the principal investigators, both of whom are bilingual in English and Spanish, pediatricians at both sites who work with low-income and minority populations, and two Registered Dieticians working at WIC.[11] The pediatricians evaluated the messages for cultural relevancy and the WIC staff ensured that the messages were consistent with WIC infant feeding messages.[11] Adjustments to the text messages were made per suggestions by the expert panel.[11] Back-translation was not part of the procedures; however, some of the messages were pre-tested in five women in Puerto Rico who were interviewed afterwards.[12] Considering the feedback gathered from the pre-testing, the final version was completed, written at a 5th grade reading level using readability analysis from Flesch-Kincaid formula for English[13] and the Fernandez-Huerta formula for Spanish.[14] Documentation for the translation process may be obtained via the principal investigators.

Although back-translation was not completed for the text messages in this intervention, participant responses indicated that the messages were easy to understand.[11] In fact, some of the most prevalent themes regarding what participants liked about the study and problems encountered showed that participants thought messages were concise, useful, and instructive, and participants had no problems understanding the messages.[11] The usefulness of back-translation has been questioned in other studies that indicated there is little evidence that it improves

accuracy[15] and that it might hinder translations on a cultural level.[9] Perhaps, an analysis of the differences in responses between Hawai‘i and Puerto Rico participants may provide information for determining if back-translation would be beneficial in future studies. Finally, although some of the messages were pre-tested in Puerto Rico, no information was collected regarding the accuracy of participants' understanding of the messages. According to the WHO guidelines, during the debriefing interview, pre-test participants should be asked to communicate in their own words what they thought the message was saying or asking; the responses should then be checked for accuracy. Pre-test participants should also be asked about words they did not understand or found offensive and given the opportunity to choose between expressions or words, if appropriate.[10] These steps should be included in the pre-test interview during future studies in developing the final version of the translated text messages.

The questionnaires were originally written in English and were administered in English in Hawai‘i and both in English and Spanish in Puerto Rico. The questionnaires were forward translated to Spanish and reviewed by the same individuals as the text messages, with the exception of a researcher in infant nutrition, who was also part of the expert panel. The questionnaires were not back-translated or pre-tested, and the final versions were developed after the expert panel approved them. Participants in Puerto Rico mainly responded to the questionnaires in Spanish; however, the codebook for qualitative analysis was written in English and, if needed, participant responses from Puerto Rico were translated into English by a bilingual graduate student for coding. Future studies may consider completing the steps of back-translation, pre-testing, and cognitive interviewing before approving the final version of the questionnaires to ensure accuracy and cultural relevancy. Additionally, forward translation should be completed by a translator whose native language is the primary language of the target culture.[10]

Validation of the food frequency questionnaire

The availability of validated dietary assessment tools for use in children is limited.[16] In particular, there are only several validated food frequency questionnaires (FFQs) for use in infants and toddlers in the US.[17] For validation of instruments that measure energy intake, doubly labeled water is the gold standard method of reference.[18] However, dietary assessment tools are

commonly validated against other similar methods,[16] instead of doubly labeled water, which subjects the tool being validated to the same limitations as the reference method.

A review of the validity of dietary assessment methods in comparison to doubly labeled water reported that for children aged 0.5 to 4 years, weighed food records provided the best estimate of energy intake.[18] Similarly, a review by the National Cancer Institute reported that test weighing, a method in which the breastfed infant is weighed immediately before and after each feeding without changing diapers or clothes and gain in weight is considered the net intake of milk, has received the most validation work in infants from birth to one year old.[19] The review indicated that energy intake estimated by doubly labeled water, direct measurement of formula, and test weighing of breastfed infants was in close agreement.[19] Based on these two reviews, weighing, either directly in weighed food records or indirectly in test weighing of breastfed infants, appears to be the most accurate method for validating dietary assessment tools aimed at measuring energy intake if doubly labeled water method is not available.

The validity of the FFQ developed for the intervention in this dissertation was assessed against two non-consecutive 24-hour recalls among a group of Hispanic infants and toddlers aged zero to 24 months from WIC Puerto Rico.[17] The FFQ, which was written in English, evaluated dietary intake over the previous seven days and was completed by 296 caregivers twice, approximately two weeks apart.[17] Two 24-hour recalls, administered approximately two weeks apart, were completed approximately one week after the FFQ.[17] High correlation between nutrient intakes assessed with the two administrations of the FFQ indicated good reproducibility of the tool, and dietary intake evaluated with the FFQ was significantly correlated with estimates from the 24-hour recalls, indicating good validity.[17] Intake estimates were consistently higher on the FFQ in comparison to the 24-hour recalls, but the authors deemed this difference reflective of more accurate reporting in the FFQ.[17] The FFQ was semi-quantitative and did not assess absolute energy intake, but it was shown to successfully rank participants' energy intake by categories,[17] and was considered a valid tool for dietary assessment in this group.

Although the FFQ was not validated against doubly labeled water, 24-hour recalls have been used in the past as comparison methods for validating other dietary assessment tools, such as FFQs.[20,21] One study that tested the accuracy of 24-hour recalls in estimating energy intake reported that three 24-hour recalls were needed to best estimate energy intake against doubly

labeled water; additional recalls did not improve the estimation and fewer recalls provided less accurate results.[21] Therefore, although the current FFQ showed good reproducibility and reliability in comparison to two 24-hour recalls, using three 24-hour recalls may have lessened the gap between intake estimates between tools, which was observed in the current study.

Future considerations for text message-based interventions

With advances in smartphone technology and as smartphone usage increases, interventions using text messaging may benefit from utilizing several different mobile phone features. For example, voice, video, camera, and Internet features may increase effectiveness of mobile interventions.[22] An example of a multi-faceted study in nutrition mHealth is the *Connecting Health and Technology Study,* which used the mobile phone camera to record food/beverage consumption and which delivered weekly text messages and dietary feedback text messages to improve nutrition behaviors in young adults.[23]

Evaluating past study designs, adapting behavioral theories for mHealth, and assessing feasibility and acceptability of interventions are important considerations for the improvement of mHealth designs. Additionally, incorporating control systems engineering[22,24] and more user feedback[25] may be helpful in expanding strategies for mHealth.

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APPENDIX

List of Appendices

Appendix A. Intervention-lactation group text messages by week of delivery

Week	Message (English)	Message (Spanish)
1	Breastfeeding is the best way to feed your baby, but it may be hard. Put your baby to your breast and you will have more milk. Call your WIC clinic for help.	La lactancia es lo mejor para tu bebe, pero a veces es difícil. Mientras mas te lo pongas al pecho, mas leche tendras. Si tienes dudas, ve a tu clínica WIC
2	When breastfeeding, make sure the nipple and the area around is inside baby's mouth. If baby eats from the tips, they will crack. Always correct the position.	Cuando pegues tu bebe al pecho, asegurate que el pezón y areola este dentro de su boca. Si coge solo el pezón te lastimara. Corrige siempre la posición.
3	To start breastfeeding again, ask for help. You only can give your milk if you put your baby to your breast often to make milk.	Si deseas lactar nuevamente busca ayuda. Puedes darle solo tu leche si lo pegas frecuentemente antes de ofrecerle formula para producir mas leche.
4	Your baby's stomach is small and your milk is easily digested so your baby drinks your milk often. That does not mean you do not have enough milk.	El estomago de tu bebe es pequeño y tu leche se digiere fácilmente por lo que tu bebe toma leche frecuentemente. Esto no significa que no produzcas suficiente.
5	You can tell if you have enough milk by counting wet diapers. Your baby should have 6 or more wet diapers every day after the 4th day of birth.	Puedes verificar que tienes suficiente leche contando los pañales mojados. Tu bebe debe tener 6 o mas pañales mojados luego del cuarto dia de nacido.
6	Breastfeed your baby from the same breast until it feels empty. That way, your baby gets the fat that comes at the end and will be full longer.	Lacta a tu bebe del mismo pecho hasta que se sienta vacio, asi recibirá mas grasa y quedara lleno por mas tiempo.
7	While breastfeeding, you do not need to eat a special diet or beverage, you only need to be hydrated. Drink 8-10 glasses of water every day.	La lactancia no requiere tomar bebidas especiales o llevar una dieta especial pero si debes estar hidratada. Toma 8-10 vasos de agua todos los dias
8	Your milk is the best food for baby for the first 6 months of life. If you cannot put your baby directly to your breast, you can give it in a bottle or cup.	Tu leche es lo mejor para tu bebe hasta los 6 meses. Si no puedes pegarlo al pecho directamente, ofrecela en vasito o botella.
9	Babies have growth spurts and want to breastfeed often, which increases hunger. You baby will drink more to increase your milk for 3 days. This is normal.	Los bebes tienen periodos de crecimiento rápido y se pegan al pecho con mas frecuencia. Comeran mas por 2-3 dias para ajustar el volumen de leche. Esto es normal
10	If you give milk in a bottle, do not add other foods such as baby cereal or baby food. If your baby seems full, do not force him/her to finish it.	Si ofreces leche en botella, no agregues alimentos adicionales como cereal de bebé o babyfood. Si parece satisfecho o lleno, no insistas a que se lo tome todo.

Appendix A continued. Intervention-lactation group text messages by week of delivery

Week	Message (English)	Message (Spanish)
11	Feed your baby when he/she moves his/her lips, sucks his/her hands and turns his/her head searching for the breast. Crying does not always mean hunger.	Alimenta a tu bebé cuando veas que tiene hambre, como mover labios, chuparse las manos y girar su cabeza buscando el pecho. No siempre que llora tiene hambre.
12	If you need to work or study, extract milk every 2-3 hours to keep up your milk production. There are laws that protect you to do this.	Si tienes que trabajar o estudiar, extraete leche cada 2-3 horas para mantener la producción. Hay leyes que te protegen para que puedas hacerlo.
13	Prepare your milk stock by extracting milk at the end of every feeding and put it in the fridge in a clean bottle. At the end of the day you will have 2-3 oz.	Prepara tu banco de leche extrayendo leche al final de cada mamada y guardala en la nevera en una botella nueva. Al final del dia tendras 2-3 oz.
14	Do not put your baby to sleep with the bottle or cup. The milk residue can lead to cavities and to excess weight.	No acuestes tu bebe con una botella o vaso. Los residuos de leche o jugo deterioran los dientes y producen caries, ademas pueden llevar al exceso de peso
15	Your baby is ready to eat when he/she sits on his/her own, opens his/her mouth, chews and leans toward foods. Wait until 6 months to start feeding solid foods.	Tu bebe esta listo para comer otros alimentos a los 6 meses, cuando sostiene su cabeza, se sienta solo y abre su boca para comer y traga
16	When your baby is 6 months, you can give meat, cereals with iron, or vegetables (puree), 1 at a time and using a spoon. Wait 3 days before giving a new food.	A los 6 meses, ofrece un alimento nuevo a la vez. Espera 3-5 dias y observa reacciones alérgicas. Comienza con 1-2 cucharadas y aumenta según su apetito
17	Give new foods using a spoon (not the bottle) and without distractions, such as watching TV. Instead, talk to baby while feeding her/him and make it fun.	Alimenta tu bebe con una cuchara (no en la botella) y sin distractores como TV, teléfonos o tabletas. Crea un momento agradable hablandole mientras lo alimentas.
18	Baby juice has sugar that babies do not need. Instead of juice, give water or fruits pureed or blended with water. This will help your baby stay healthy.	Los jugos no se recomiendan en el 1er año. Ofrece agua o frutas en puré o trituradas con agua. Estos consejos ayudarán a que tu bebé este sano.

Note: WIC=The Special Supplemental Nutrition Program for Women, Infants, and Children

Appendix B. Intervention-formula group text messages by week of delivery

Week	Message (English)	Message (Spanish)
1	For the first 6 months of life, your baby only needs breast milk. It is very healthy and high in fat with enough energy to grow.	Durante los primeros 6 meses, tu bebe solo necesita leche materna. La leche materna es saludable; es alta en grasa para darle la energia necesaria para crecer.
2	Breastfeeding has many benefits for your baby, such as protecting him/her from getting sick because it has antibodies that fight infections.	La lactancia tiene muchos beneficios para tu bebe, como protegerlo de enfermedades porque tiene anticuerpos que le ayudan a combatir infecciones.
3	Breastfeeding is the best way to feed your baby, but it may be hard. Put your baby to your breast and you will have more milk. Ask for help.	La lactancia es lo mejor para tu bebe, pero a veces es difícil. Mientras mas te lo pongas al pecho, mas leche tendras. Si tienes dudas, busca ayuda
4	Breastfeeding does not have to hurt. If your baby opens the mouth wide, the nipples will be ok. If your baby eats from the tip of the nipple, it will crack.	La lactancia no tiene que ser dolorosa. Si tu bebe abre bien la boca al ponerlo sobre la parte oscura de tu pecho, no te lastimara. Si come de la punta de tus pezones, se romperan.
5	To start breastfeeding again, ask for help. You only can give your milk if you put your baby to your breast often to make milk.	Si deseas lactar nuevamente busca ayuda. Puedes darle solo tu leche si lo pegas frecuentemente para producir mas leche antes de ofrecerle formula para producir mas leche.
6	Your baby's stomach is small and your milk is easily digested so your baby drinks your milk often. That does not mean you do not have enough milk.	El estomago de tu bebe es pequeño y tu leche se digiere fácilmente por lo que tu bebe toma leche frecuentemente. Esto no significa que no produzcas suficiente.
7	If you are not able to breastfeed or choose not to, formula with iron is the best choice for feeding your baby during the first year of life.	Si no puedes lactar o decidiste no hacerlo, la formula con hierro es la mejor alternativa para alimentar a tu bebe en el 1er año.
8	You can tell if you have enough milk by counting wet diapers. Your baby should have 6 or more wet diapers every day after the 4th day of birth.	Puedes verificar que tienes suficiente leche contando los pañales mojados. Tu bebe debe tener 6 o mas pañales mojados luego del cuarto dia de nacido.
9	Your milk is the best food for baby for the first 6 months of life. If you cannot put your baby directly to your breast, you can give it in a bottle or cup.	Tu leche es lo mejor para tu bebe hasta los 6 meses. Si no puedes pegarlo al pecho directamente, ofrecela en vasito o botella.

Appendix B continued. Intervention-formula group text messages by week of delivery

Week	Message (English)	Message (Spanish)
10	If you give milk in a bottle, do not add other foods such as baby cereal or baby food. If your baby seems full, do not force him/her to finish it.	Si ofreces leche en botella, no agregues alimentos adicionales como cereal de bebé o babyfood. Si parece satisfecho o lleno, no insistas a que se lo tome todo.
11	Feed your baby when he/she moves his/her lips, sucks his/her hands and turns his/her head searching for the breast. Crying does not always mean hunger.	Alimenta a tu bebé cuando veas que tiene hambre, como mover labios, chuparse las manos y girar su cabeza buscando el pecho. No siempre que llora tiene hambre.
12	If you need to work or study, extract milk every 2-3 hours to keep up your milk production. There are laws that protect you to do this.	Si tienes que trabajar o estudiar, extraete leche cada 2-3 horas para mantener la producción. Hay leyes que te protegen para que puedas hacerlo.
13	Prepare your milk stock by extracting milk at the end of every feeding and put it in the fridge in a clean bottle. At the end of the day you will have 2-3 oz.	Prepara tu banco de leche extrayendo leche al final de cada mamada y guardala en la nevera en una botella nueva. Al final del dia tendras 2-3 oz.
14	Do not put your baby to sleep with the bottle or cup. The milk residue can lead to cavities and to excess weight.	No acuestes tu bebe con una botella o vaso. Los residuos de leche o jugo deterioran los dientes y producen caries, ademas pueden llevar al exceso de peso
15	Your baby is ready to eat when he/she sits on his/her own, opens his/her mouth, chews and leans toward foods. Wait until 6 months to start feeding other foods.	Tu bebe esta listo para comer otros alimentos a los 6 meses, cuando sostiene su cabeza, se sienta solo y abre su boca para comer y traga
16	When baby is 6 months, offer a new food using a spoon. Wait 3 days before giving a new food. Start with 1-2 Tbsp and increase guided by your baby's appetite.	A los 6 meses, ofrece un alimento nuevo usando la cuchara. Espera 3 dias antes de dar otro alimento. Comienza con 1-2 cdas y aumenta segun apetito
17	Give new foods using a spoon (not the bottle) and without distractions, such as watching TV. Instead, talk to baby while feeding her/him and make it fun.	Alimenta tu bebe con una cuchara (no en la botella) y sin distractores como TV, teléfonos o tabletas. Crea un momento agradable hablandole mientras lo alimentas.
18	Baby juice has sugar that babies do not need. Instead of juice, give water or fruits pureed or blended with water. This will help your baby stay healthy.	Los jugos no se recomiendan en el 1er año. Ofrece agua o frutas en puré o trituradas con agua. Estos consejos ayudarán a que tu bebé este sano.

Appendix C. Control group text messages by week of delivery

Week	Message (English)	Message (Spanish)
1	Put your baby to sleep on his/her back to prevent crib death or sudden infant death syndrome.	Pon a tu bebe a dormir sobre su espalda para evitar la muerte de cuna o del síndrome de muerte subita
2	Follow the Manufacturer's Guide when installing baby's car seat. Until 2 years of age, seats must be rear-facing and secured in the back seat of the car.	Sigue la guia del fabricante al instalar el asiento de bebe en el carro. Los asientos deben estar orientados hacia atrás y asegurado en el asiento trasero del carro hasta 2 años
3	Cuddling with baby skin-to-skin lowers stress and crying, improves blood pressure and blood sugar, heart and breathing rates, and may promote immune function.	Abrazar a tu bebe piel con piel reduce el estrés y llanto, mejora la presión y nivel de azucar en sangre, el ritmo cardíaco y respiratorio, y la funcion inmune.
4	If baby is breathing fast and hard, is unable to swallow or cry, turning dusky or blue in color, he/she is having a serious problem and needs to go to the ER	Si tu bebe esta respirando rapido y duro, no puede tragar o llorar, o su piel esta oscura o azul, tiene un problema grave y tiene que ir a la sala de emergencias
5	Vaccines need to be given BEFORE baby is exposed. Follow the recommended schedule to protect from serious diseases that strike in the first year of life.	Las vacunas deben ponerse antes de exponer al bebé. Siga el programa recomendado de vacunas para protegerlo de enfermedades graves en el primer año de vida.
6	Fever is never harmful, but a baby under 2 months of age who has a temperature over 100.4 degrees should see the doctor right away.	La fiebre NUNCA es perjudicial, pero un bebe menor de 2 meses de edad que tiene una temperatura de más de 100,4 grados debe ir al médico enseguida.
7	The sting of a shot lasts for a moment and is quickly forgotten. Comfort your baby by smiling, speaking in a soft and calm voice and holding him / her close.	El dolor de una inyección dura solo un momento y rapidamente se olvida. Conforta a tu bebe sonriendo, hablando en una voz suave y tranquila y sosteniéndolo cerca
8	Extra blankets, crib bumpers and stuffed animals should never be placed in baby's bed. These can cause suffocation.	Las frizas, cubrecamas y animales de peluche no deben colocarse nunca en la cama del bebé. Pueden causar asfixia.
9	To soothe the redness, warmth and swelling of a vaccination, you may give baby a cool bath or apply a cool compress to the shot site.	Para calmar el enrojecimiento, calor e hinchazón de una vacuna, puedes darle a tu bebe un baño frío o aplicar una compresa fría en el lugar

Appendix C continued. Control group text messages by week of delivery

Week	Message (English)	Message (Spanish)
10	Don't be tempted to leave your baby in the bath or on the changing table. It only takes an instant for baby to slip under the water or roll off the table.	Nunca debes dejar a tu bebe solo en el baño o en la mesa de cambiar pañales. Sólo toma un instante para el bebé se deslice bajo el agua o de la mesa
11	Cough and cold medications do not work and are not safe for babies. Only give your baby medications that were prescribed for him or her by the doctor.	Los medicamentos para la tos y resfriado no funcionan y no son seguros para los bebes. Solo dale a tu bebe los medicamentos prescritos por su medico.
12	Make it a habit to check the back seat every time you leave the car so you never forget baby. Temperatures in a car can cause heatstroke and death in minutes.	Haz un habito de siempre verificar el asiento trasero cada vez que sales del carro para que nunca se te olvide tu bebe. Las temperaturas en un carro cerrado pueden causar insolacion y la muerte en minutos.
13	Babies startle and lurch without warning. Never pass hot liquids, such as coffee or soup, over a baby. The most painful burn is the one you may have prevented.	Los bebes se sobresaltan y se mueven bruscamente sin previo aviso. Nunca pases liquidos calientes, como café o sopa por encima del bebe para evitar quemaduras
14	If your baby has asthma, avoid common triggers, such as dust, roaches, dog and cat hairs, which could make the wheezing worse	Si tu bebe tiene asma, evita los desencadenantes comunes, tales como pelos de polvo, cucarachas, perros y gatos, ya que podrían hacer peor el ataque de asma.
15	A baby who is vomiting over and over or having frequent watery diarrhea may get dehydrated. If not making wet diapers baby should see the doctor immediately.	Un bebe que este vomitando una y otra vez, o que tiene diarrea acuosa frecuente puede deshidratarse. Si no tiene pañales mojados debe llevarlo al médico inmediatamente.
16	Cigarette smoke in hair and clothing increases the likelihood of SIDS, asthma attacks and ear infections. Don't let anyone smoke in the home or around baby.	El humo de cigarrillo en pelo y en la ropa aumenta la probabilidad de muerte subita, ataques de asma y las infecciones del oido. No permitas que nadie fume en el hogar o cerca de tu bebe
17	When babies teethe, they may fuss and drool. Your baby may enjoy teething toys. You do not need to give medicine and never put liquor on the gums.	Cuando le salen los dientes a los bebes, se quejan y babean. A tu bebe le pueden gustar los juguetes para la dentición. No necesita medicina y nunca le pongas licor en las encías
18	If prescribed medicine by the doctor, give exactly as instructed. Use a syringe to measure, rather than a spoon.	Si tu medico le receta medicinas a tu bebe, debes darlas exactamente como te lo indicaron. Utiliza una jeringa para medir en lugar de una cuchara.

Note: WK=week; ER=emergency room; SIDS=sudden infant death syndrome

Appendix D. Research subject information and consent form

TITLE: Multi-site trial using short mobile messages (SMS) to improve infant weight

SPONSOR: The study is funded by the Research Centers for Minority Institutions (RCMI) Translational Research Network (RTRN).

PRINCIPAL INVESTIGATOR: Cristina Palacios, PhD. Nutrition Program, School of Public Health, University of Puerto Rico Medical Sciences Campus.

CO-PRINCIPAL INVESTIGATOR: Jinan Banna, PhD, RD. Department of Human Nutrition, Food and Animal Sciences, University of Hawaii at Manoa.

SITE: Department of Human Nutrition, Food and Animal Sciences, University of Hawaii at Manoa.

STUDY-RELATED PHONE NUMBERS: Dr. Jinan Banna, Tel 808-956-7857

1) INTRODUCTION

You and your infant are invited to participate in a research study. This document will inform you about the purpose, risks, and benefits of participating in this research study. This consent may contain words that you do not understand. Please feel free to ask the study investigator or the study staff any questions or to explain any words or information that you do not clearly understand. You may take home an unsigned copy of this consent form to think about and/or discuss with your family or friends before making your decision.

You should sign this document only after you have been given all the necessary information, all your questions have been answered, understand all the procedures and have had enough time to decide whether you wish to participate.

2) PURPOSE OF THE STUDY

The primary purpose of this study is to test an intervention delivered through short mobile messages (SMS) focused on infant feeding. We will require your participation in the study for 4 months from recruitment (when your baby is 0-2 months). This study will be done in Puerto Rico and in Hawaii.

3) STUDY PARTICIPANTS

Taking part in this study is voluntary. You may decide not to take part or leave the study at any time. Your decision will not cause any penalty or loss of benefits from the usual medical care to which you are entitled.

In our study, a total of 200 parent or caregivers and their infants will participate from WIC clinics in Puerto Rico and in Hawaii (100 in each site). You can participate in this study if you are 18 years and older, own a mobile phone and are able to receive weekly messages, are the main caregiver of your infant, if your baby is 0-2 months of age, was born after the 37^{th} week of gestation, had adequate birthweight for gestational age (birthweight 10th to 90^{th} percentile according to the growth curve), is a participant of WIC and has no special diets. You cannot

participate if you are unwilling to comply with your assigned group, either to the intervention or the control group, or are not able to read.

4) PROCEDURES

Study participants will be assigned at random (like flipping a coin) to one of two study groups: intervention or control group. Both groups will participate in 2 visits as described below. These visits will be done in the WIC clinics.

Visit 1

In this visit we will do the following:

1. We will measure the weight and length of your baby wearing light clothing and clean diaper.
2. You will complete a short questionnaire with your contact information
3. We will ask you to complete a short questionnaire with questions about your gender, age and level of education and health. Also, we will ask questions about your baby, such as weight at birth, week of pregnancy in which she/he was born and pregnancy-related health questions.
4. We will ask you questions about breastfeeding, age of introduction of foods, juices, water, and questions on how you feed your baby.
5. We will ask you questions on the frequency that your baby consumed certain foods in the last week.

This visit will take about 30-40 minutes.

Visit 2

This visit will be completed 4 months later (when your baby is about 4-6 months). During this visit, you will repeat the same procedures as the first visit. This visit will take about 20-30 minutes to complete.

Additional procedures for those assigned to the intervention group

If you are assigned to the intervention group, you will receive weekly text messages on how to feed your baby. You will also be asked to reply to a few questions sent by text messages throughout the study. In addition, we will ask you a few questions about the messages received at the end of the study (during visit 2). These extra questions during visit 2 will take about 10 minutes.

Additional procedures for those assigned to the control group

If you are assigned to the control group, you will receive weekly text messages on the general health of your baby.

5) RISK AND DISCOMFORTS

Risks or discomforts for participating in this study are minimal. You may feel uncomfortable when asked your personal and your baby's food intake information. You may refuse to answer any questions. You could feel inconvenience when receiving the weekly text messages.

6) BENEFITS

The study may or may not benefit you or your child personally. You will receive feedback on your child's nutrition at the end of the study.

7) COSTS

All costs associated with the research procedures will be covered by this study.

8) PARTICIPATION AND VOLUNTARY WITHDRAWAL

Your decision to take part in these procedures is voluntary. This authorization will be effective until the study ends, unless you decide to cancel it earlier. You can cancel this authorization at any time by sending a notification to the Principal Investigator to the following address:

Jinan Banna, PhD, RD, CDN
Assistant Professor
Department of Human Nutrition, Food and Animal Sciences
College of Tropical Agriculture and Human Resources
Agricultural Sciences 216
University of Hawaii at Manoa
1955 East-West Rd
Honolulu, HI 96822

9) FINANCIAL COMPENSATION

You will receive a compensation of $50 for participating in the study. This will be provided at the end of the study (visit 2). This compensation is intended to cover the time, travel, meals, or other expenses that are directly related to your participation in the study.

10) PRIVACY AND CONFIDENTIALITY

All the information that you provide will be maintained under strict confidentiality. The results of this study will be presented or published only in summary form. Your information will be coded with identification numbers, and your data will be stored using only these identification numbers. Individual information including your name, address or any other identifying information will not be stored with your medical information and will not be used for the data analysis, reports or publication. This information will be used to keep regular contact with you during the study period. Your identifying information will be stored for up to 10 years after all the data collection for the study is completed and will be seen only by the few study team members who need this information to conduct the study. However, if the need arises your information could be examined by the relevant authorities including the U.S. Food and Drug Administration, the U.S. Department of Health and Human Services agencies, and the University of Hawaii at Manoa Institutional Review Board. As an example, the research staff is legally obligated to notify government authorities in the event that intimate partner violence or child abuse/neglect is suspected.

11) USE OF INFORMATION FOR FUTURE USE

I authorize ___, I do not authorize ___ the researcher, Jinan Banna, to keep my personal information on a data bank to be contacted in the future for other research studies.

12) COMPENSATION FOR INJURY

I understand that if I am injured in the course of this research procedure, I may be responsible for the costs of treating my injuries.

13) QUESTIONS

If you have any questions about this research project please contact Dr. Jinan Banna at 808 956 7857, Department of Human Nutrition, Food and Animal Science, 1955 East West Road, AgSc 314C HI-96822.

If you have any questions regarding your rights and participation as a research subject, please contact the IRB Administration at 808 956 5007or write to IRB Administration, Biomed Bldg. 1960 East-West Road, Rm. B-104, Honolulu, HI 96822. The IRB Administration has also developed a web site designed to make you familiar with your rights. The web site discusses your basic rights as a research participant, an explanation of the informed consent process, the basic requirement that written consent be in a language understandable to you, and suggested sample questions to ask the research investigator regarding your participation in the study. This web site can be accessed at: http://www.hawaii.edu/irb/.

14) CONSENT

I have read the information in this consent form, or it has been read to me. All my questions about the study and my participation in it have been answered. I freely consent to be in this research study. I authorize the use and disclosure of my health information to the parties listed in the authorization section of this consent for the purposes described above. By signing this consent form, I have not given up any of my legal rights.

_____
Participant Name (in print)

_____ _____
Signature of Participant Date

_____ _____
Signature of Person Conducting Informed Consent Date

For participants who are unable to read or write or in case that the participant is a not an emancipated minor and requires parental legal consent, also complete the signature block below:

_____ _____
Witness* or Parent Name (in print) Date

_____
Witness or Parent Signature

*Witness is impartial and was present for the consent process.

Appendix E. General questionnaire on demographic data and health

ID: _____
Date: _____
WIC clinic_____

I. Parents/caregiver data:

1. Age: _____
2. Sex: Female_____ Male_____
3. Are you Hispanic or Latino? Yes ☐ No ☐

Please select one or more Race/s.

☐ Native Hawaiian ☐ American Indian ☐ Other Pacific Islander
☐ Alaska Native ☐ Black/African American ☐ White
☐ Asian

4. What is your relationship to the baby?
   mother_____ father_____ grandparent_____ other____
5. What was the highest grade you completed in school?: (e.g., 7th, GED, Bachelors of Arts)

   _____
6. If you are in school, at what level are you studying?:_____
7. If you are working, when do you plan to return to work?: _____
8. Number of children: _____

II. Data about pregnancy:

9. Weeks of gestation at delivery: _____
10. How much weight did you gain during pregnancy: _____(pounds)
11. What was your weight before pregnancy: _____
12. Height:_____
13. Did you use prenatal vitamins during pregnancy? Yes_____ No:_____
14. Pregnancy complications:
    ___ High blood sugar (diabetes)
    ___ High blood pressure (hypertension)
    ___ Low blood count (Anemia)
    ___ Vomiting throughout pregnancy
    ___ Overweight/obesity
    ___ Others: _____

III. Data about baby:

15. Gender: Girl _____ Boy _____
16. Age: _____(months)
17. Birth weight: _____(ounces) Birth height:_____ (inches)
18. Where does your baby get well baby care?: _____
19. Is the baby up to date with vaccines? Yes_____ No _____
20. If you were breastfeeding, did you take vitamins while nursing?: Yes___No:___

IV. Acceptability to a sample of blood on your baby

Would you agree, in future studies, to take a sample of 1 – 2 drops of blood from your baby's heel? This is similar to the sample taken at the hospital at birth.

Yes_____ No_____

V. Weight and height of the baby [the staff must take these measures].

Weight

Measure 1 _____lb _____ oz
Measure 2 _____lb _____ oz
Measure 3 _____lb _____ oz (measure if the difference between 1 and 2 is >3.5 oz)

If the baby is anxious or uneasy, weight in with the adult

Measure 1 _____lb _____ oz (adult), _____lb _____ oz (adult+baby)

Height

Measure 1 ____cm or _____ inches
Measure 2 ____cm or _____ inches
Measure 3 ____cm or _____ inches (measure if the difference between 1 and 2 is >0.5 cm

Appendix F. General infant feeding practices

ID ____
ID staff ____

1. When you were pregnant, did you plan to breastfeed your baby?
   _____ No
   _____ Yes

2. Did you get any help with breastfeeding?
   ___ No
   ___ Yes From whom? (doctor, midwife, friend, family)
   _____

3. Did you breastfeed your baby, even once?
   ___ No
   ___ Yes

4. If you never nursed your baby, what was the main reason?
   _____

5. Were you able to breastfeed your baby immediately after birth?
   ____ No
   ____ Yes

6. Were you able to breastfeed your baby in the hospital?
   ____ No
   ____ Yes

7. Are you still breastfeeding your baby?
   ____ No
   ____ Yes

- If yes, what type of breastfeeding are you practicing?
  ____ EXCLUSIVE breastfeeding (only giving breast milk, no other foods given, including formula)?
  ____ PARTIAL breastfeeding (combining with formula)

- If PARTIAL breastfeeding, is it . . .
  ___ mostly breastfeeding?
  ___ about half and half?
  ___ mostly formula feeding?
- If you are no longer breastfeeding your baby, how old was your baby when you stopped nursing? ____ months

- What was the **main** reason you stopped breastfeeding your baby?
  ____Not enough milk
  ____Heard it was painful
  ____Baby didn't stay onto the breast
  ____Flat or inverted nipples
  ____Formula was more convenient
  ____Shame of breastfeeding in public
  ____It was too painful
  ____Concern about changes to my breasts and body
  ____Had to go back to school or work
  ____Too tired, needed more rest
  ____Worried baby might get too clingy, dependent
  ____Worried that my diet or my smoking was bad for baby
  ____Father, grandparents or other family need to be close to / care for baby

8. Did you have a breast pump?
   ____ No
   ____ Yes. How often did you use it?: ___almost every day
   ___about 2-3 times per week
   ___about 1 time per week
   ___less than 1 time per week

9. At what age did your baby start eating/drinking the following?

Food or beverage	Age introduced (months)	Mark "X" if this food was never introduced to your baby
Water		
Juice		
Formula		
Cow's milk		
Other milk (soy, almond, etc.)		
Any solid foods (cereal, baby food, poi, banana, other fruits & vegetables, Vienna sausage, other meats, eggs, rice, cookies/crackers, soups, etc.)		

10. Do you add cereal your baby's milk bottle? ____ No ____ Yes

- If yes, how old was your baby when you first started doing this? ____months

- If yes, how many times do you add cereal to your baby's milk bottle?
  ___ times per day or ____ times per week

11. Do you add poi to your baby's milk bottle? ____ No ____ Yes

- If yes, how old was your baby when you first started doing this? ____months

- If yes, how many times do you add poi to your baby's milk bottle?
___ times per day or ____ times per week

14. Do you add any other food to your baby's milk bottle?
____ No
____ Yes, Which one(s)?_____

15. When feeding your baby a bottle of milk (formula or breastmilk), do you usually?
___encourage him/her to drink it all
___encourage him/her to drink some more when he/she stops drinking
___take away the bottle and encourage him/her to drink some more a little later
___take away the bottle and stop the feeding

16. How often did you put your baby to bed with a bottle of milk?
___Every time ___Almost never
___Most times ___Never
___Sometimes

17. If your baby started eating solids, how do you feed him/her?
___ mainly using a spoon
___ mainly adding it to the bottle
___ sometimes with a spoon and sometimes adding in to the bottle
___ chew the food before feeding it to baby
___ other ways. Specify_____

18. When feeding your baby, do you usually?
___feed him/her without distractions
___feed him/her while the rest of the family is eating
___feed him/her while watching TV/tablet/cellphone
___feed him/her while he/she is playing

Appendix G. Food frequency questionnaire for infants

ID Participant_____
ID staff_____
Date:_____(month/day/year)

A. Food consumption

In the last 7 days and nights, how many times did your baby eat or drink the following? Include those foods and drinks given to the baby by you and others, such as grandparents, babysitters, etc.

Fill only 1 column for each food:

- If your baby ate a food once a day or more, write the number of times per day in the first column.
- If your baby ate a food less than once a day, write the number of times per week in the second column.
- If your baby did not eat this food in the last week, write 0 in the second column.
- If your baby consumed mixed plates, write each meal separately.

FOODS	Check only one column for each food: TIMES PER DAY	TIMES PER WEEK
1. Breast Milk		
2. Formula - Specify brand (e.g. Similac Advance)_____		
How did you mix it? _____ powder: ___ number of scoops; ___ ounces of water _____ concentrated liquid: ___ ounces of formula; ___ ounces of water _____ ready to use: ___ ounces		
Has your baby consumed any other foods or drinks, including water? Indicate below. If not, go to section B		
3. Water		
4. Cow's milk - How much did your baby have each time? __4oz or less __ 6oz __8oz __10oz __12oz or more		
5. Milk with chocolate/strawberry or vanilla (include frozen beverages, shakes, hot chocolate, etc) - If you added sugar, how much did you add? _____ teaspoons - How much did your baby have each time? __4oz or less __ 6oz __8oz __10oz __12oz or more		
6. Other milks (example: soy, rice, almond, goat, etc.) - Write most common type consumed this week_____ - How much did your baby have each time? __4oz or less __ 6oz __8oz __10oz __12oz or more		
7. Cheese		
8. Ice cream		
9. Yogurt		
10. Soy foods: tofu, soy frozen desserts, etc.		
11. Orange juice 100% (not orange beverage)		

FOODS	TIMES PER DAY	TIMES PER WEEK
12. 100% fruit or vegetable juice (examples: apple, pear, grape, cranberry, carrot, tomato, etc.) - Write the most common consumed_____ - Specify type: _____ Juice for babies (example: Gerber, Heinz) _____Regular juice 100% (not baby juice) - How much did your baby have each time? __2oz __4oz __ 6oz __8 oz __10oz or more		
13. Other fruit beverages (examples: Hi-C, Spacegang, Sunny D, etc.) - How much did your baby have each time?: __2oz __4oz __ 6oz __8oz __10oz		
14. Sodas (examples: Coca-Cola, Pepsi, 7-Up, Rootbeer, etc.) - How much did your baby have each time?: __2oz __4oz __ 6oz __8oz __10oz		
15. Kool-Aid, Tang, Iced Tea (examples: Nestea, Lipton, etc.) - How much did your baby have each time?: __2oz __4oz __ 6oz __8oz __10oz		
16. Hot cereal (examples: baby rice cereal, cream of wheat, oatmeal, corn mush, etc.) ONLY INCLUDE IF EATEN WITH A SPOON - Write the most common_____ - If you added sugar, how much? _____ teaspoons - How much did your baby eat each time? USE THE PICTURES __1oz (2 tbsp) __2.5oz (5 tbsp) __4oz (½ cup/8tbsp) __6oz (¾ cup/10tbsp) __8oz (1cup)		
17. Baby cereal added to the bottle (examples: baby rice, wheat or corn cereal, mixed cereals, etc.) - How many scoops/teaspoons did you add to the bottle each time?_____		
18. Ready to eat breakfast cereals (examples: Corn flakes, Frutipebbles etc.) - Write the most common _____ - How much did your baby eat each time? USE THE PICTURES __1oz (2 tbsp) __2.5oz (5 tbsp) __4oz (½ cup/8tbsp) __6oz (¾ cup/10tbsp) __8oz (1cup)		
19. Rice and pasta - Regular____ or whole grain____? - How much did your baby eat each time? USE THE PICTURES __1oz (2 tbsp) __2.5oz (5 tbsp) __4oz (½ cup/8tbsp) __6oz (¾ cup/10tbsp) __8oz (1cup)		
20. Bread (examples: sandwich bread, dinner roll, bagel, French bread, tortilla…) - Regular____ or whole grain____?		
21. Pancake, waffles, French toast, cinnamon rolls, etc. - Regular____ or whole grain____?		
22. Crackers (examples: soda, Ritz, Cheese-it, etc.) - Regular____ or whole grain____?		
23. Pizza, turnovers, tacos, other fried foods, etc.		

FOODS	TIMES PER DAY	TIMES PER WEEK
How much bread, pancakes, crackers, pizza did your baby eat each time? USE THE PICTURES ___ ½ slice of bread / ½ pancake/waffle (4") / 2 crackers / ¼ slice of medium pizza ___ ¾ slice of bread / ¾ pancake/waffle (4") / 3 crackers / 1/3 slice of medium pizza ___ 1 slice of bread / 1 pancake/waffle (4") / 4 crackers / ½ slice of medium pizza ___ 1.5 slice of bread / 1.5 pancake/waffle (4") / 5 crackers / 2/3 slice of medium pizza		
24. Banana - Specify the most common: ___ fresh ___ baby food		
25. Apple - Specify the most common: ___ fresh ___ baby food ___ jar/canned		
26. Pear - Specify the most common: ___ fresh ___ baby food ___ jar/canned		
27. Citrus fruits (examples: orange, mandarin, etc.) - Specify the most common: ___ fresh ___ baby food ___ jar/canned		
28. Melon - Specify the most common: ___ fresh ___ baby food		
29. Mango and papaya - Specify the most common: ___ fresh ___ baby food		
30. Other fruits, specify: _____ - Specify the most common: ___ fresh ___ baby food ___ jar/canned		
How much of any type of fruit did your baby eat each time? USE THE PICTURES __1oz (2 tbsp) __2.5oz (5 tbsp) __4oz (½ cup/8tbsp) __6oz (¾ cup/10tbsp) __8oz (1cup)		
31. Carrot - Specify the most common: ___ raw or cooked at home ___ baby food ___ jar/canned/frozen		
32. Green beans - Specify the most common: ___ raw or cooked at home ___ baby food ___ jar/canned/frozen		
33. Corn - Specify the most common: ___ raw or cooked at home ___ baby food ___ jar/canned/frozen		
34. Pumpkin/squash - Specify the most common: ___ raw or cooked at home ___ baby food ___ jar/canned/frozen		
35. Other vegetables (examples: tomato, lettuce, broccoli, etc.) - Specify the most common: ___ raw or cooked at home ___ baby food ___ jar/canned/frozen		
How much of any type of vegetables did your baby eat each time? *USE THE PICTURES* __1oz (2 tbsp) __2.5oz (5 tbsp) __4oz (½ cup/8tbsp) __6oz (¾ cup/10tbsp) __8oz (1cup)		
36. Potato or sweet potato		
37. French fries		

FOODS	TIMES PER DAY	TIMES PER WEEK
38. Plantain		
39. Other vegetables (yucca, yautia, celery, breadfruit)		
40. Beans, pigeon peas, chickpeas, etc.		
41. Beef or pork (includes hot dogs, sausage and baby foods)		
42. Chicken or Turkey (any preparation, includes ham, canned, baby food)		
43. Canned fish (examples: tuna fish or salmon)		
44. Other fish		
45. Egg (Whole, egg white or yolk)		
46. Peanuts, Peanut butter and other nuts		
How much beans, meat, chicken, fish, eggs or peanut butter did your baby eat each time? USE *PICTURES* __1oz (2 tbsp) __2.5oz (5 tbsp) __4oz (½ cup/8tbsp) __6oz (¾ cup/10tbsp) __8oz (1cup)		
47. Candies (chocolate, bonbon, lolly pop, etc.)		
48. Cake, muffins, donuts, etc.		
49. Cookies (sugar cookies, chocolate chips, oats, etc.)		
50. Others candies/sweets; Specify:_____		
How much of cookies, cakes, muffins or donuts did your baby eat each time? USE THE PICTURES ____ 1 cookie / ¼ piece of cake / ¼ muffin / ¼ donut ____ 2 cookies / ½ piece of cake / ½ muffin / ½ donut ____ 3 cookies / ¾ piece of cake / ¾ muffin / ¾donut ____ 4 cookies / 1 piece of cake / 1 muffin / 1 donut		
51. Honey, jam, syrup, agave - How much did your baby eat each time? *USE THE PICTURES* ___ ½ tsp (¼ oz) ___ 1 tsp (½ oz) ___2 cdas (1 oz) ___3 cdas (1.5 oz)		
52. Chips (examples: Doritos, Lays, Cheetos, Tostitos, etc.) - How much did your baby eat each time? ___¼ oz or ¼ of a bag ___½ oz or ½ of a bag ___1 oz or 1 bag ___2 oz or a medium bag ___3 oz or 30 chips ___4 oz or 40 chips		
53. Margarine/butter		
54. Oil		

B. **Use of vitamin and mineral supplements.** How often did you give your baby any of these supplements in the last 7 days? Mark with an X the frequency for each supplement

Supplements	No	1-3 times per week	4-6 times per week	1 per day	2 per day
1. Iron drops					
2. Fluorine drops					
3. Vitamin D drops					
4. Folic acid					
5. Multi-vitamins for babies - Specify name:_____					

Appendix H. Screening checklist for study participants

	Yes	No
1. Are you 18 years or older and a WIC participant?	_____	_____
2. Is your baby between 0 and 2 months old?	_____	_____
3. Was your baby born after the 37th week of gestation?	_____	_____
4. Is your baby on a normal diet and free of disabilities that makes it hard for him/her to move?	_____	_____
5. Are you the main person in charge of caring for your baby?	_____	_____
6. Are you able to participate in the study for 4 months, respond to questions sent via text message and come to the final visit in 4 months?	_____	_____
7. Do you own a phone that is able to receive unlimited text messages?	_____	_____
8. Are you willing to participate regardless of the group to which you are assigned?	_____	_____
9. Was your baby's birthweight adequate for his/her gestational age (birthweight 10th to 90th percentile according to the growth curve)? Plot it……	_____	_____

Appendix I. Script for the baseline visit

For this visit, you will need

1. Informed consent (2 copies, one for participant)
2. Participant ID List
3. Contact form
4. General sociodemographic questionnaire
5. General feeding practices questionnaire
6. FFQ
7. Visuals to assist in estimation of portion size
8. Anthropometrics manual
9. Growth charts and weight percentile/conversion tables

A. Introduction

[Research staff] *Hi, my name is ___. Congratulations on your new baby! Before you start your appointment to add baby to your WIC account, I would like to ask you a couple of questions. I know that [with my children I found it/many mothers find it] extremely helpful to get advice or tips and reminders from fellow mothers and professionals about how to take care of [my/their] baby, especially in those first few months. So we were wondering if you would like to receive short text messages once a week for a few months that would give you helpful reminders and tips about how to best take care of baby. These messages might be about tips regarding feeding baby or reminders about other ways to care for your baby. And, these messages are completely free as long as you get free text messaging on your phone. You will receive $50 after all messages are sent. Do you think you are interested in getting these messages as part of a research study?*

Yes → great, first I will first ask you a few questions to determine if you qualify [ask screening questions]. If she qualifies, then continue with section B.

No→ it is ok, thanks for your time. If you change your mind, we will be here during the next few weeks.

If the person was screened and does not qualify: Save the completed screening form in a separate folder with the reason the person is not eligible indicated. If the reason is something different from the questions listed, note it on the form.

B. Explain consent form

- Explain all sections of the consent form.
- Then, ask if she has questions and answer them.
- Ask the participant to explain in her own words what is involved in the study.
- If she is clear, then ask her to write her name, sign and add date in the consent form. The consent is invalid if all 3 parts are not completed. Finally, you must also sign and provide a copy of the consent to the participant.

C. Complete questionnaires

- Write down the participant's name in the "Participant ID List" and tell her the assigned ID to complete the questionnaires
- Provide all the questionnaires using a clipboard, give her a pen and ask her to complete these following this order (make sure she writes down her ID and date):
  - Contact form
  - General sociodemographic questionnaire
  - General feeding practices questionnaire
- When she is done, complete the Infant FFQ – THIS WILL BE INTERVIEWER ADMINISTERED. Make sure you use the visuals to help mothers estimate the portion sizes.

D. Weight and length

When the participant is done completing all the questionnaires:

- Ask the participant to place her infant in the scale to assess weight. Follow the Anthropometrics manual (you should always have this manual with you). Make sure never to carry the baby, ask mom to do this. You can only correct the position of the infant in the scale.
- Then ask the participant to place the infant in the stadiometer. Follow the Anthropometrics manual

E. Explain the SMS

If someone is assigned to the intervention group: to decide whether someone goes into the lactation or formula intervention group, see what the initial breastfeeding status was per the general feeding practices questionnaire. If they answered yes to the below question, then they would go into the breastfeeding group.

Are you still breastfeeding your baby?

____ No
____ Yes

Explain to the participant that we would now like to help her to enter the study using her cell phone by sending a message from her phone that will allow her to do so. Then, ask for the participant's phone and send a message to **313131** using the keyword corresponding to the correct group. The words to text are as follows (be sure there is a space between the two):

Control group	EZHII27909 CR
Intervention: formula	EZHII27909 IVF
Intervention: lactation	EZHII27909 IVL

Explain that when the study starts, she will receive 1 SMS per week. She can respond or send comments and questions; we will try to answer them. Every other week we will ask her a short question by SMS to which she should respond.
In 4 months, we will coordinate the last visit to repeat the assessments done today. Then, we will pay her $50 for her participation.

F. Goodbye

Thank the participant for her time and tell her that we will be in touch.

Appendix J. Interview guide for assessing acceptability

Assessing acceptability of the intervention via semi-structured qualitative interview

Welcome

Thank you for being here today. My name is _____. I am from the department of Human Nutrition, Food and Animal Sciences at the University of Hawaii at Manoa.

Background

Today we would like to speak with you about your experience receiving the SMS as part of the project you participated in related to infant feeding. In our discussion, we will ask to hear your opinions about them. We will make improvements to our program according to the suggestions we hear from everyone we are interviewing, so your thoughts are very important to us.

Specific Questions

Thinking back on the messages you were sent, which SMS were the most useful to you in feeding your infant [show list of SMS]? Why?

Thinking back on the messages you were sent, which SMS were the least useful to you in feeding your infant [show list of SMS]? Why?

Now, I would like to learn more about how these messages may have affected how you fed your baby. Were there any messages that led you to feed your baby in a certain way, or make changes in what you might normally do? If so, which ones were these, and how did they influence the way you feed your baby?

Now, I would like to ask you to tell me more about your experiences using the SMS messaging. Could you tell me about anything you really liked about receiving messages? [Pause for response] Now, could you tell me more about any problems you experienced receiving messages?

Is there anything else you would like to tell us about your experience receiving the SMS?

Probing Questions
What do you mean by that?

Could you tell me more about [insert specific topic]?

Closing
Your responses today have been very helpful to us. We will note of the information you have shared with us and see how we may improve our program if needed. Thank you very much for your participation.

Appendix K. Research subject information and consent form (Spanish)

INFORMACIÓN DE LA PARTICIPANTE EN LA INVESTIGACIÓN Y FORMULARIO DE CONSENTIMIENTO

Título: Estudio multi-centro para probar mensajes cortos de textos para mejorar el peso infantil

Patrocinador: El estudio es financiado por la Red de Investigación Translacional (RTRN, por sus siglas en inglés), del Centro de Investigación para Centros Minoritarios (RCMI, por sus siglas en inglés).

INVESTIGADORA: Dra. Cristina Palacios, Programa de Nutrición.

LUGAR: Programa de Nutrición, Escuela Graduada de Salud Pública, Recinto de Ciencias Médicas de la Universidad de Puerto Rico

NÚMEROS DE TELÉFONOS ASOCIADOS AL ESTUDIO: Dra. Cristina Palacios, Tel 787-758-2525, Ext. 1433 o 787-421-6951.

Esta hoja de consentimiento puede contener palabras que usted no entienda. Por favor, pregunte al investigador encargado o a cualquier personal del estudio para que le explique cualquier palabra o información que usted no entienda claramente. Usted puede llevarse a su casa una copia de este consentimiento para pensar sobre este estudio o para discutir con su familia o amigos antes de tomar su decisión.

1. INTRODUCCIÓN

Usted ha sido invitado a participar en un estudio de investigación. Antes de que usted decida participar en el estudio, por favor, lea este consentimiento cuidadosamente. Haga todas las preguntas que usted tenga, para asegurarse de que entienda los procedimientos del estudio, incluyendo los riesgos y los beneficios.

2. PROPÓSITO DEL ESTUDIO

El propósito es probar una intervención usando mensajes de textos enfocados en la alimentación del bebé. Le pedimos su participación en el estudio por 4 meses, desde el reclutamiento (cuando su bebé tiene 0-2 meses). Este estudio se realizará en Puerto Rico y en Hawái.

3. PARTICIPANTES DEL ESTUDIO

La participación en este estudio es voluntaria y los participantes pueden dejar de participar del estudio en cualquier momento sin repercusiones. En nuestro estudio, un total de 200 padres/cuidadores y sus bebes participarán de las clínicas WIC en Puerto Rico y en Hawái (100 en cada sitio). Usted puede participar en este estudio si tiene 18 años o más, poseer un teléfono móvil y tener la capacidad de recibir mensajes de textos semanales, es la o el principal encargada(o) del cuidado del bebé, si su bebé tiene 0-2 meses de edad, nació después de la semana 37 de gestación, tuvo un peso al nacer adecuado para su edad gestacional al nacer (peso al nacer entre los percentiles 10 y 90 según las curvas de crecimiento – el cual será evaluado por el reclutador al momento de la entrevista), es participante de WIC y no tiene dietas especiales. No puede participar si no está dispuesto a cumplir con su grupo asignado (intervención o control) o no sabe leer.

4. PROCEDIMIENTOS

Los participantes del estudio serán asignados al azar (como lanzar una moneda) a uno de los dos grupos de estudio: grupo de intervención o de control. Ambos grupos participarán de 2 visitas como se describe a continuación. Estas visitas se harán en las clínicas de WIC.

Visita 1.

En esta visita haremos lo siguiente:

1. Mediremos el peso y la longitud de su bebé con ropa ligera y pañal limpio.
2. Usted completará un cuestionario corto con su información de contacto.
3. Usted completará un cuestionario corto con preguntas sobre su género, edad y nivel de educación y salud. Además, le haremos preguntas acerca de su bebé, tales como peso al nacer, semana del embarazo al nacer y preguntas de salud relacionadas con el embarazo.
4. Le haremos preguntas acerca de la lactancia materna, edad de introducción de los alimentos, jugos, agua y preguntas sobre cómo alimenta a su bebé.
5. Le haremos preguntas acerca la frecuencia que su bebé consumió ciertos alimentos la semana pasada.

Esta visita tomará alrededor de 30-40 minutos.

Visita 2:

Esta visita se completará 4 meses más tarde (cuando su bebé tenga aproximadamente de 4 a 6 meses). Durante esta visita, repetirá los mismos procedimientos que la primera visita. Esta visita tomará aproximadamente 20-30 minutos para completar.

Procedimientos adicionales para aquellos asignados al grupo de intervención

Se usted es asignada/o al grupo de intervención, recibirá mensajes de texto semanales sobre cómo alimentar a su bebé. Se le pedirá que responda algunas preguntas enviadas por mensajes de texto durante el estudio. También le haremos algunas preguntas acerca de los mensajes recibidos al final del estudio (durante la Visita 2). Estas preguntas adicionales tomarán unos 10 minutos.

Procedimientos adicionales para aquellos asignados al grupo control

Se usted es asignada/o al grupo control, recibirá mensajes de texto semanales sobre la salud general de su bebé.

5. RIESGOS O INCOMODIDADES

Los riesgos o incomodidades por participar en este estudio son mínimos. Usted podría sentirse incomodo al preguntársele información personal y sobre la ingesta alimentaria de su bebé. Usted puede negarse a contestar alguna pregunta. Podría sentir inconveniencia al momento de recibir los mensajes de texto semanales.

6. BENEFICIOS

Es probable que usted no reciba ningún beneficio personal por participar en este estudio. Usted recibirá comentarios sobre la nutrición de su bebé al final del estudio.

7. COSTOS

No hay ningún costo por participar del estudio.

8. PARTICIPACIÓN Y RETIRO VOLUNTARIOS

La participación suya en este estudio es voluntaria y usted puede decidir no participar o retirarse del estudio en cualquier momento. Usted puede cancelar esta autorización en cualquier momento mediante el envío de una notificación al Investigador Principal a la siguiente dirección:

Cristina Palacios
UPR-RCM, Escuela Graduada de Salud Pública, Programa de Nutrición
P.O. Box 365067 San Juan PR 00936-5067

Si usted cancela esta autorización, el Investigador Principal no utilizará ni divulgará su información personal ni de su salud bajo la autorización para este estudio. Esta información sólo se divulgará en caso que se necesite la información personal de su salud para preservar la integridad científica del estudio.

La autorización para el uso y el acceso de la información protegida de la salud para los propósitos de la investigación es totalmente voluntaria. Sin embargo, de no firmar este documento usted no podrá participar en este estudio. Si en el futuro usted cancela esta autorización, no podrá continuar participando en este estudio.

9. INCENTIVO PARA EL PARTICIPANTE

Usted recibirá una compensación de $50 para cubrir sus gastos asociados a las visitas del estudio. Se entregará el incentivo en la última visita del estudio (visita 2), una vez completado todos los aspectos del estudio.

10. PRIVACIDAD Y CONFIDENCIALIDAD

Si usted elige estar en este estudio, el investigador del estudio conseguirá información personal sobre usted y sobre su bebé. El investigador del estudio podría brindar información sobre usted y su salud que podrían identificarle al Comité de Derechos Humanos (IRB siglas en inglés) de la Universidad de Puerto Rico (UPR), Recinto de Ciencias Médicas (RCM). Información sobre usted y sobre su salud que puede identificarle a usted podría ser brindada a otros para realizar este estudio de investigación. El personal del estudio analizará y evaluará los resultados del estudio. Los expedientes estarán guardados bajo llave y los datos se guardarán en una computadora/tableta protegida por una contraseña en el Programa de Nutrición de la Escuela Graduada de Salud Pública, RCM-UPR.

Los resultados de esta investigación pueden ser publicados en revistas científicas o ser presentados en las reuniones médicas, pero la identidad suya no será divulgada. La información puede ser revisada por el IRB de la UPR, RCM, la cual está conformada por un grupo de personas quienes realizarán la revisión independiente de la investigación según los requisitos de las regulaciones. La información de salud suya será mantenida tan confidencial como sea posible bajo la ley. La información recolectada de usted será guardada bajo llave.

11. USO DE LA INFORMACIÓN PARA USO FUTURO

Autorizo ___ o no autorizo ___ (colocar iniciales) al investigador, Cristina Palacios, para mantener mi información personal en un banco de datos para ser contactado en el futuro para otros estudios de investigación. Esta información se mantendrá bajo llave. De no autorizar esto no afectaria su participación en este estudio

12. COMPENSACIÓN EN CASO DE DAÑO

En el caso de lesión física y/o mental como resultado de este estudio, usted recibirá tratamiento médico libre de costo en el Hospital Universitario o cualquier otro hospital designado por el Rector del RCM, UPR.

La Universidad de Puerto Rico no ofrecerá ninguna forma de remuneración directamente a usted. Sin embargo, firmando esta forma de consentimiento usted no renunciará a cualquier derecho legal.

13. PREGUNTAS

Si tiene alguna pregunta sobre este estudio o sobre su participación en el mismo, usted puede contactar a Cristina Palacios, Investigadora Principal al 787-758-2525, Extensión 1433.

Si usted tiene alguna pregunta sobre sus derechos como participante del estudio, usted puede contactar la Oficina de Protección de Participantes Humanos en Investigación, teléfono 787-758-2525, extensiones 2510 a la 2515 o a opphi.rcm@upr.edu.

No firme este consentimiento a menos que usted haya tenido la oportunidad de hacer preguntas y recibir contestaciones satisfactorias para todas sus preguntas. Si usted firma aceptando participar en este estudio, recibirá una copia firmada, con el sello de aprobación de IRB y con la fecha de esta hoja de consentimiento para usted.

14. CONSENTIMIENTO

He leído la información de este documento de consentimiento, o se me ha leído de manera adecuada. Todas mis preguntas sobre el estudio y mi participación en el mismo han sido contestadas. Yo libremente consiento a participar en este estudio de investigación. Yo autorizo el uso y la divulgación de mi información de salud a las entidades antes mencionadas en la sección de autorización de este consentimiento para los propósitos descritos anteriormente. Al firmar esta hoja de consentimiento, no he renunciado a ninguno de mis derechos legales.

Nombre del participante (en letra de molde)	Firma del Participante	Fecha

Firma del personal encargado	Fecha

Para las participantes que no saben leer ni escribir, o en el caso de que la participante sea menor de edad no emancipada y requiera el consentimiento legal de sus padres, completar lo siguiente:

Testigo* o Nombre de Padre/Madre (en letra molde)	Firma	Fecha

*El testigo es imparcial y estuvo presente en el proceso de consentimiento.

Appendix L. General Questionnaire on Demographic Data and Health (Spanish)

ID: _____
Fecha_____
ID staff:____
Clínica WIC:_____

I. Datos sobre el padre/madre/guardián:

1. Edad: _____
2. Sexo: Femenino_____ Masculino_____
3. Relación con el bebé: madre_____ padre_____ abuelo/a_____ otro/a____
4. Nivel de educación alcanzado (ejemplo: 6to grado, superior, bachillerato, etc.) _____
5. Si está estudiando actualmente, cual nivel está estudiando?_____
6. Si usted no trabaja actualmente, cuando planifica regresar a trabajar? _____
7. Número de hijos: _____

II. Datos sobre el embarazo:

8. Semanas de gestación al momento del parto: _____
9. Aumento de peso total en el embarazo: _____(libras)
10. Peso antes del embarazo: _____
11. Talla:_____
12. Uso de vitaminas prenatales durante el embarazo: Si_____ No:_____
13. Complicaciones en el embarazo:

___ Azúcar en sangre alta (diabetes)
___ Presión alta (hipertensión)
___ Anemia
___ Vómitos persistentes durante todo el embarazo
___ Sobrepeso/Obesidad
___ Otras: _____

III. Datos sobre el bebé:

14. Género: Niña _____ Niño _____
15. Edad: _____(meses)
16. Peso al nacer: _____(onzas) Talla al nacer:_____ (pulgadas)
17. Tipo de centro pediátrico al cual lleva a su bebé:_____
18. Esta al día con las vacunas? Si_____ No _____
19. Si lacta, esta tomando vitaminas? Si_____ No:_____

IV. Aceptabilidad a una muestra de sangre en su bebé

Estaría usted de acuerdo en un futuro estudio a que se le tome una muestra de 1-2 gotas de sangre del talón de su bebé? Esto es similar a la muestra tomada en el hospital al nacer.

Si_____ No_____

VI. Peso y talla del bebé [el personal debe tomar estas medidas]. Nota: si está disponible, tome las medidas en kilogramos y especificar que es en kg.

Peso

Medida 1 ____libras ___ oz
Medida 2 ____libras ___ oz
Medida 3 ____libras ___ oz (sólo tomar si la diferencia entre la medida 1 y 2 es > 3.5 onzas)

Si el bebé no se deja, pesarlo con un adulto

Medida 1 ___lb__oz (adulto), ___lb__oz (adulto+bebé)
Medida 2 lb oz (adulto), lb oz (adulto+bebé)

Talla

Medida 1 ____cm
Medida 2 _____ cm
Medida 3 ____cm (sólo tomar si la diferencia entre la medida 1 y 2 es >0.5 cm)

Appendix M. General Infant Feeding Practices (Spanish)

ID ____
ID staff ____

1. ¿Durante su embarazo, planificó amamantar a su bebé?
   ___ No
   ___ Sí

2. ¿Recibió apoyo de algún profesional de la salud para iniciar la lactancia?
   ___ No
   ___ Sí ¿De quién? _____

3. ¿Alguna vez su bebé fue amantado, aunque sea una sola vez?
   ___ No
   ___ Sí

4. Si nunca lactó a su bebé, ¿Cuál fue la razón principal?
   _____

5. ¿Logró amamantar a su bebé inmediatamente después del parto?
   ___ No
   ___ Sí

6. ¿Comenzó el proceso de lactancia durante su hospitalización postparto?
   ___ No
   ___ Sí

7. ¿Si su bebé fue amamantando o recibió leche materna, continúa haciéndolo?
   ___ No
   ___ Sí

   - Si es si, ¿qué tipo de lactancia está practicando?
     ____ Lactancia EXCLUSIVA (solamente leche materna, no consume otros alimentos, incluyendo formula)
     ____ Lactancia PARCIAL (combinada con formula)

   - Si es lactancia PARCIAL, ¿es mayormente?:
     ___ Lactancia
     ___ Mitad lactancia y mitad formula
     ___ Mayormente alimentación con formula

- Si no está lactando a su bebé,
  ¿Qué edad tenía su bebé cuando paró de lactarlo? ____ meses

- ¿Cuál fue la razón principal por la cual dejó de lactar a su bebé?

____No tenia suficiente leche
____Oí que era doloroso
____El bebé no se quedó en el pecho
____Pezones planos o invertidos
____La fórmula era más conveniente
____Vergüenza de amamantar en público.
____Fue muy doloroso
____Preocupación por los cambios en mis pechos y el cuerpo
____Tuve que volver a la escuela o al trabajo
____Demasiada cansado, necesitaba descansar
____Preocupada de que el bebé sea muy dependiente
____Preocupada que mi dieta o el fumar era malo para el bebé
____Padre, abuelos u otros familiares tienen que estar cerca de / cuidar del bebé

8. ¿Usted tiene/tuvo acceso a un extractor de leche materna?
   ____ No
   ____ Si. ¿Con qué frecuencia usted la utiliza?: ___ Casi todos los días
   ___ De 2-3 veces por semana
   ___ Alrededor de 1 vez por semana
   ___ Menos de 1 vez a la semana

9. ¿Qué edad tenía cuando comenzó a tomar o comer los siguientes alimentos o bebidas?

Alimentos o bebidas	Edad de introducción (meses)	Marque aquí con una "X" si nunca se ha introducido
Agua		
Jugos		
Formula		
Leche de vaca		
Otras leches (soya, almendra, etc)		
Cualquier alimento sólido (cereal, baby food, frutas, vegetales, carnes, galletas, sopas, cremas, etc.)		

10. ¿Le añade cereal dentro del biberón de leche de su bebé?
    ____ No
    ____ Si, ¿Qué edad tenía su bebé la primera vez que lo hizo? ____meses

11. ¿Cuántas veces le añade cereal dentro del biberón de leche de su bebé?

___ veces por día ó ___ veces a la semana

(ponga cero si nunca le añade cereal al biberón)

12. ¿Le añade babyfood dentro del biberón de leche de su bebé?

____ No

____ Si, ¿Qué edad tenía su bebé la primera vez que lo hizo? ____meses

13. ¿Cuántas veces le añade babyfood dentro del biberón de leche de su bebé?

___ veces por día ó ___ veces a la semana

(ponga cero si nunca le añade cereal al biberón)

14. Le añade algún otro alimento al biberón de leche?

____ No

____ Si, ¿cual(es)?_____

15. ¿Cuándo le da a su bebé un biberón de fórmula o leche materna, generalmente usted?

___lo anima a que se tome todo

___lo anima a que se tome un poco más

___toma el biberón y lo anima a beber un poco más después de un rato

___toma el biberón y detiene la alimentación

16. ¿Con cuál frecuencia pone a su bebé a dormir con el biberón de leche?

___ Siempre ___ Casi nunca

___ Bastante frecuente ___ Nunca

___ Algunas veces

17. Si su bebé está comiendo alimentos sólidos, ¿Cómo lo alimenta?

___ Mayormente usando cuchara

___ Mayormente añadiendo los alimentos al biberón

___ Algunas veces con cuchara y otras veces añadiéndolos al biberón

___ Otras formas. Especifique_____

18. Cuando alimenta a su bebé, generalmente usted?

___lo alimenta sin distracciones

___lo alimenta con el resto de la familia

___lo alimenta mientras ve la TV/tablet/celular

___lo alimenta mientras juega con sus juguetes

Appendix N. Food Frequency Questionnaire for Infants (Spanish)

ID: _____
ID staff:_____
Fecha_____(mes/día/año)

A. Consumo de alimentos

En los últimos 7 días y noches, ¿con qué frecuencia su bebé consumió los siguientes alimentos? Incluya los alimentos dados por usted y otras personas (papá, abuelos, cuidadores, etc.).

Anote solo 1 columna por alimento:
- Si su bebé consumió un alimento una vez al día o más, anote el número de veces por día en la primera columna.
- Si su bebé consumió un alimento menos de 1 vez al día, anote el número de veces por semana en la segunda columna.
- Si su bebé no consumió un alimento en los últimos 7 días, anote 0 en la segunda columna.
- Si su bebé consumió platos mixtos, anote cada alimento por separado.

Marque solo una columna para cada alimento

ALIMENTOS	**VECES POR DÍA**	**VECES EN SEMANA**
1. Leche materna		
2. Fórmula - Indique marca (ejemplo Similac Advance: _____		
¿Cómo lo mezcló?: _____ polvo: ___ número de scoops; ___ onzas de agua _____ líquida concentrado: ___ onzas de fórmula; ___ onzas de agua _____ lista para usar: ___ onzas		
Si su bebe no consumió ningún otro alimento o bebida, vaya a la sección B		
3. Agua		
4. Leche de vaca - ¿Cuánta leche tomó cada vez? ___4oz o menos ___ 6oz ___8oz ___10oz ___12oz o más		
5. Leche con chocolate, fresa o vainilla o chocolatina (incluya frappe o batidas a base de leche, hot chocolate, etc.) - Si le añadió azúcar, ¿cuánto le añadió? _____ cucharaditas - ¿Cuánta leche tomó cada vez? ___4oz o menos ___ 6oz ___8oz ___10oz ___12oz o más		
6. Otras leches (ejemplo: soya, arroz, almendra, cabra, etc.) - Indique la que más consumió su bebé _____ - ¿Cuánta leche tomó cada vez? ___4oz o menos ___ 6oz ___8oz ___10oz ___12oz o más		
7. Queso		
8. Mantecado		
9. Yogur		
10. Alimentos de soya: tofú, postres de soya congelados, etc.		
11. Jugo de china 100% (no bebida de china)		

ALIMENTOS	VECES POR DÍA	VECES EN SEMANA
12. Jugo 100% de fruitas o vegetales (ejemplos: manzana, pera, uva, cramberry, zanahoria, tomate, etc. - Indique el que más consumió_____ - Indique el tipo: _____ Jugo para bebés (ejemplo: Gerber, Heinz) _____Jugo regular 100% (no incluya jugos para bebés) - ¿Cuánto tomó cada vez? ___2oz ___4oz ___ 6oz ___8 oz ___10oz o más		
13. Otras bebidas de frutas (ej.: Hi-C, Spacegang, Sunny D, Caprisun, etc.) - ¿Cuánto tomó cada vez?: ___2oz ___4oz ___ 6oz ___8 oz ___10oz		
14. Refrescos (ejemplos: Coca-Cola, Pepsi, 7-Up, Malta, Icee etc.) - ¿Cuánto tomó cada vez?: ___2oz ___4oz ___ 6oz ___8 oz ___10oz		
15. Kool-Aid, Tang, Té dulce (ejemplos: Nestea, Lipton, etc.) - ¿Cuánto tomó cada vez?: ___2oz ___4oz ___ 6oz ___8 oz ___10oz		
16. Cereal o cremita (ejemplos: cereal de bebé de arroz, farina, avena, maicena, etc) *SOLO INCLUIR EL CONSUMIDO CON CUCHARITA* - Indique el que más consumió su bebé esta semana_____ - Si le añadió azúcar, ¿cuánto le añadió? _____ cucharaditas - ¿Cuánto comió su bebé cada vez? *USAR VISUAL* ___1oz (2 cdas) ___2.5oz (5 cdas) ___4oz (½ taza/8cdas) ___6oz (¾ taza/10cdas) ___8oz (1t)		
17. Cereal añadido al biberón (ejemplos: cereal de arroz, trigo, Nestun de 3 o 5 cereales, maicena, etc) - ¿ Cuántas scoops/cucharaditas le añadió al biberón cada vez?_____		
18. Cereales secos de desayuno (ejemplos: Corn flakes, Frutipebbles etc.) - Indique el que más consumió su bebé esta semana_____ - ¿Cuánto comió su bebé cada vez? *USAR VISUAL* ___1oz (2 cdas) ___2.5oz (5 cdas) ___4oz (½ taza/8cdas) ___6oz (¾ taza/10cdas) ___8oz (1t)		
19. Arroz y pasta - Indique si generalmente son regulares____ o integrales____ - ¿Cuánto comió su bebé cada vez? *USAR VISUAL* ___1oz (2 cdas) ___2.5oz (5 cdas) ___4oz (½ taza/8cdas) ___6oz (¾ taza/10cdas) ___8oz (1t)		
20. Panes (pan especial, pancillos, pan de panadería, bagels, plantillas, etc) - Indique si generalmente son regulares____ o integrales____		
21. Pancake, waffles, tostadas francesas, mayorcas, cinnamon rolls, etc. - Indique si generalmente son regulares____ o integrales____		
22. Galletas saladas (ejemplo: export soda, Ritz, Cheez-it, etc.) - Indique si generalmente son regulares____ o integrales____		
23. Pizza, empanadillas, tacos, pastelillos, frituras, alcapurrias, croquetas, relleno de papa, arepas, sorullos, etc.		

ALIMENTOS	VECES AL DÍA	VECES EN SEMANA
¿Cuánto de panes, pancakes, galletas, pizza comió su bebé cada vez? *USAR VISUAL* ___ 1/2 rebanada de pan / 1/2 pancake/waffle (4") / 2 galletas / 1/8 rebanada de pizza ___ 3/4 rebanada de pan / 3/4 pancake/waffle (4") / 3 galletas / 3/8 rebanada de pizza ___ 1 rebanada de pan / 1 pancake/waffle (4") / 4 galletas / 1/4 rebanada de pizza ___ Más de 1 rebanada de pan / 1 pancake/waffle (4") / 4 galletas / 1/4 rebanada de pizza		
24. Guineo - Indique la forma más común: ___ fresco ___ baby food		
25. Manzana - Indique la más común: ___ fresca ___ baby food ___ de pote/enlatada		
26. Pera - Indique la más común: ___ fresca ___ baby food ___ de pote/enlatada		
27. Frutas cítricas (ejemplos: china, mandarina, etc.) - Indique la más común: ___ fresca ___ baby food ___ de pote/enlatada		
28. Melón - Indique la forma más común: ___ fresco ___ baby food		
29. Mango y papaya - Indique la forma más común: ___ fresco ___ baby food		
30. Otras frutas, indique: _____ - Indique la más común: ___ fresco ___ baby food ___ de pote/enlatada		
¿Cuánto de cualquier fruta comió su bebé cada vez? *USAR VISUAL* __1oz (2 cdas) __2.5oz (5 cdas) __4oz (½ taza/8cdas) __6oz (¾ taza/10cdas) __8oz (1t)		
31. Zanahorias - Indique la más común: ___fresco (crudo/cocinada) ___baby food ___pote/enlatada/congelada		
32. Habichuelas tiernas - Indique la más común: ___fresco (crudo/cocinada) ___baby food ___pote/enlatada/congelada		
33. Maíz - Indique la más común: ___fresco (crudo/cocinada) ___baby food ___pote/enlatada/congelada		
34. Calabaza/squash - Indique la más común: ___fresco (crudo/cocinada) ___baby food ___pote/enlatada/congelada		
35. Otros vegetales (ejemplos: tomate, lechuga, brócoli, etc.) - Indique la más común: ___fresco (crudo/cocinada) ___baby food ___pote/enlatada/congelada		
¿Cuánto de cualquier vegetal comió su bebé cada vez? *USAR VISUAL* ___1oz (2 cdas) ___2.5oz (5 cdas) ___4oz (½ taza/8cdas) ___6oz (¾ taza/10cdas) ___8oz (1t)		
36. Papa o batata		
37. Papas fritas		

ALIMENTOS	VECES AL DÍA	VECES EN SEMANA
38. Plátano		
39. Otras viandas (yuca, yautía, apio, pana)		
40. Habichuelas, gandules, garbanzos, etc.		
41. Carne de res o cerdo (incluye hot dogs, salchichas, jamón, baby foods)		
42. Pollo o pavo (de cualquier forma, jamón, enlatado, baby foods, etc.)		
43. Pescado enlatado (ejemplos: atún o salmón)		
44. Otros pescados		
45. Huevo (entero, clara o yema)		
46. Maní, mantequilla de maní y otras nueces		
¿Cuánto de habichuelas, carnes, pollo, pescado, huevo o nueces comió su bebé cada vez? *USAR VISUAL* ___1oz (2 cdas) ___2.5oz (5 cdas) ___4oz (½ taza/8cdas) ___6oz (¾ taza/10cdas) ___8oz (1t)		
47. Dulces (chocolate, bombón, paletas, etc.)		
48. Bizcochos, muffins, donas, rosquillas		
49. Galletas (de azúcar, de chocolate chips, de avena, etc.)		
50. Otros dulces; indique:_____		
¿Cuánto de galletas, bizcochos, muffins o donas comió su bebé cada vez? *VISUAL* _____ 1 galletita / ¼ de pedazo de bizcocho / ¼ de muffin / ¼ de dona _____ 2 galletitas / ½ pedazo de bizcocho / ½ de muffin / ½ de dona _____ 3 galletitas / ¾ pedazo de bizcocho / ¾ de muffin / ¾ dona _____ 4 galletitas / 1 pedazo de bizcochos / 1 de muffin / 1 dona		
51. Miel, mermelada, sirope, jarabes - ¿Cuánto comió su bebé cada vez? *USAR VISUAL* ___½ cda (¼ oz) ___1 cda (½ oz) ___2 cdas (1 oz) ___3 cdas (1.5 oz)		
52. Papitas o chips (ejemplos: Doritos, Lays, Cheetos, Tostitos, etc.)		
¿Cuánto de papitas o chips comió su bebé cada vez? ___ ¼ oz o ¼ bolsita ___½ oz o ½ bolsita ___1 oz o bolsita ___ 2oz o bolsa mediana ___ 3oz o 30 chips ___Más de 3oz o 30 chips		
53. Margarina/mantequilla		
54. Aceite		

B. **Uso de suplementos de vitaminas y minerales.** ¿Con que frecuencia le dio a su bebé estos suplementos en los últimos 7 días? Marque con una X una sola frecuencia para cada suplemento

Suplemento	No	1-3 veces en semana	4-6 veces en semana	1 vez al día	2 veces al día
1. Gotas de hierro					
2. Gotas de flúor					
3. Gotas de vitamina D					
4. Ácido fólico					
5. Multi-vitaminas para bebés - Nombre:_____					

Appendix O. Interview Guide for Assessing Acceptability (Spanish)

La evaluación de la aceptabilidad de la intervención a través de la entrevista semi-estructurada cualitativa

Guía de entrevista

Bienvenida

Gracias por estar aquí hoy. Mi nombre es _____. Soy del Programa de Nutrición de la Escuela Graduada de Salud Publica del Recinto de Ciencias Medicas, UPR.

Transfondo

Hoy nos gustaría hablar con usted acerca de su experiencia de recibir los mensajes de textos como parte del estudio que participó sobre la alimentación infantil. En nuestra discusión, nos gustaría escuchar sus opiniones acerca de estos mensajes. Vamos a introducir mejoras en nuestro programa de acuerdo a las sugerencias que escuchamos de todas las personas que estamos entrevistando, por lo que sus opiniones son muy importantes para nosotros.

Preguntas Específicas

Pensando en los mensajes que se enviaron, ¿cuales mensajes fueron las más útiles en la alimentación de su bebé [mostrar lista de SMS]? ¿Por qué?

Pensando en los mensajes que se enviaron, ¿cuales mensajes fueron los menos útiles en la alimentación de su bebé [mostrar lista de SMS]? ¿Por qué?

Ahora, me gustaría aprender más acerca de cómo estos mensajes pueden haber afectado la forma en que usted alimentó a su bebé. ¿Hubo algún mensaje que le llevó a alimentar a su bebé de una manera determinada, o hacer cambios en lo que normalmente puede hacer?

Si es así, ¿cuáles eran estos?; ¿cómo influyeron en la forma de alimentar a su bebé?

Ahora me gustaría hacerle algunas preguntas sobre el registro que usted guardó con sus experiencias utilizando la mensajería de textos. ¿Usted anotó cuales les gustó? / ¿Anotó los problemas experimentados? [anotar detalles específicos señalados en el registro].
¿Me podría decir más sobre esto?

¿Hay algo más que le gustaría contarnos sobre su experiencia de recibir los mensajes de textos?

Preguntas para conocer mas detalles

¿Qué quiere decir con eso?

¿Me podría decir más sobre [insertar tema específico]?

Cierre

Sus respuestas hoy han sido de gran ayuda para nosotros. Tomaremos en cuenta la información que ha compartido con nosotros y ver cómo podemos mejorar nuestro programa, si es necesario.

Muchas gracias por su participación.